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THE JEQUIÉ MANICOBA RUBBER TREE.

BY R. THOMSON.

This new species of rubber is indigenous to the State of Bahia, Brazil. It is a small tree, attaining a height of some 25 feet, with stems from 18 to 20 inches in circumference. It is a closely-allied species of the Ceara rubber, the native habitat of which is separated from this Manicoba region by some five or six degrees of latitude. Until a few years ago this rubber was unknown to commerce. It grows under peculiar conditions as a product of the forest. In the region I traversed, there are millions of trees, including saplings. The soil in which the Manicoba grows is peculiar (I have samples of it in London). It is a porous kind of clay, more porous than sticky, the texture of which is eminently conducive to the well-being of the tree during prolonged periods of drought to which it is exposed. Apart from the peculiar character of the soil, its great depth powerfully contributes to the conservation of the moisture which it freely absorbs during the short rainy seasons. In other words, the absorbent power of this great body of earth, not only relieves the surface

of any excess of moisture, but retains the moisture during severe droughts, so that the soil is never water-logged, and never excessively dry. *This soil, therefore*, occupied with the aridity of the climate, is the secret of the existence and diffusion of this rubber tree.

A few years ago I was deputed by Messrs. Elder, Dempster and Co., to investigate the resources of the Pine-apple region of Florida. I mention this by way of pointing out the disparity between that soil and the Manicoba soil. I quote from my published report:—"If the soils of Florida were anything like the soils of Jamaica, it is safe to say that Pine-apples would not be cultivated there at all. The soil in which they are planted consists of from 96 to 98 per cent of silica. The growers furnish all the food by fertilizers, which bring forth luxuriant crops . . . On examining a large Pine-apple field that had been some months before uprooted in order to prepare the land for re-planting, I saw many hundreds of rejected suckers that had been cast away over the land actually bearing fruit! In other words, these suckers yielding fruit had no connection with the soil, other than ying on the surface. I was puzzled. But, on reflection, I arrived at the conclusion, that this phenomenal productiveness was due to the great depth of the bed of sand, probably 50 feet, which issued moisture from its huge mass on the principle of capillary attraction."

The supreme importance of soil is further exemplified by the following extract from the *India-rubber World*:—

"After having travelled through all the desirable rubber regions in Central America and Northern South America, I am satisfied that suitable tropical forests which can be had now at a low price—often for a few cents an acre—present an opportunity for the profitable employment of capital such as has seldom been offered in the world's history, but the serious point is to secure the proper land. Those who acquire it will have more than they expect, but natural rubber lands are not to be had by simply making a chance location. Though the tree will grow almost anywhere, it is only the most favoured spots that will yield those spontaneous

returns that are so very profitable. It is fair to state that if people go to taking up tropical forests promiscuously, ten will be disappointed to every one who secures a prize."

In the remote district in which this tree grows, the vegetation may be described as a scrub forest. The Manicoba tree throughout certain areas intermingles with the stunted trees and forms a prominent part of the forest at an elevation of 1,000 to 2,000 feet above sea-level. In the forest there are comparatively few species of trees that exceed a medium size. The country is gently undulating, with low intervening hills. The whole region presents the aspects of a semi-desert, consequent on the character of the soil, which is non-productive of luxuriant tropical vegetation.

Throughout this dreary tract of country, embracing many thousands of square miles, miles at a time are destitute of inhabitants. Running streams of water, so impressive and emblematic of fertile regions, are few and far between throughout the district. At distances, usually many miles asunder, the configuration of the land admits of natural reservoirs which, aided by simple devices, supply the wants of man and beast. Thus, the water is collected at the bases of hills and sloping lands where cavities are formed. Wild animals, including insects, are also rarely encountered. In this connection it is worthy of note that cultivated Manicoba trees appeared to be practically immune from insect depredations. Ants sometimes overhaul the young leafage, and a young tree is sometimes snapped off at the top by a stray deer.

Another noteworthy feature of this scrub forest may be indicated. The foliage is scant and lacks profuse development in conformity with the stunted tree vegetation, but it is accompanied by innumerable growths of thorns and spines that contest supremacy with the foliage itself. I have travelled on horseback through many thousands of miles of tropical lands, but never through any part having a tithe of these formidable weapons. The sterility of the region is mainly accountable for this evolution of thorns. Most of the species become thorny, and the thorny species are reproduced superabundantly.

Notwithstanding the severe droughts characteristic of this region (probably the rainfall does not exceed 25 inches a year), droughts lasting six months, and even nine months at a time, many shrubby species of the natural order *Malvaceae* were constantly found in proximity to Manicoba trees. I am intimately acquainted with many species belonging to this order in the tropics, and I was surprised to see numerous species flourish under such conditions of aridity. There can be no doubt that this phenomenon is ascribable to the peculiar structure of the soil. Many species of *Carti* are interspersed in the scrubby thickets, these being more concentrated at points where the soil is exceptionally arid. It was curious to see several species of palms, moisture-loving plants, struggling for existence in these ungenial thickets. Half-a-dozen species of native *Ficus*, fine umbrageous trees, flourish adjacent to settlements. (I thought that *Ficus elastica*, *R.*, among rubber, could be grown to perfection here.) Ferns are non-existent, though I saw after riding 360 miles, a few puny plants in a dark ravine. I visited a coffee plantation at about 3,000 feet altitude. This was the only coffee plantation on an area of many thousands of square miles. The coffee plants yield very small fruit. At this height frequent rains are experienced. And coming from the inland towards the City of Bahia, rains are more frequent, the soil is darker—an ameliorating factor. Tobacco of splendid quality is extensively cultivated here by thousands of small settlers. In juxtaposition *Cassava* (Manioc), the staple food product of Brazil, a congener of Manicoba, maize and other products, in patches, are commonly cultivated, and crops are obtainable therefrom a few months after the rainy season.

In a report of mine issued by the Agricultural Society of Jamaica, about a year ago, on the Virgen rubber of Columbia (it has been reprinted in many countries), I emphasized the importance of rubber cultivation in comparison with the sparse returns obtainable from wild trees. This is applicable to Para rubber and all other important species of rubber, including Manicoba. In a state of nature, rubber trees struggle for existence amidst a

thousand other species of trees. In the near future all rubber must be produced by cultivation like any other great agricultural commodity.

During the past year various owners of Manicoba rubber land have been directing attention to the culture of this tree. I visited several plantations ranging from a few acres to a hundred acres. I was anxious to investigate the cultural capabilities of the tree. The owners of these lands are ignorant of the lines on which this culture should be initiated. They take it for granted that sticking the Manicoba seeds or cuttings into cleared ground is all that is necessary without further attention. One important factor is in their favour: I refer to the wonderful tenacity of life and recuperative power pervading this plant. The primitive procedure by which the incipient seedlings and cuttings are left to take care of themselves with a view to establishing plantations, is antagonistic to the development of the trees, for nothing is more important than the proper treatment of young plants in the establishment of great prospective plantations. The result of the preliminary attempts in question was an aggregation of maltreated plants. In this connection it may be noted that about half-a-dozen labourers only, men who know nothing about rubber cultivation, and nobody to instruct them, perform all the work appertaining to the upkeep of such plantations, comprising some fifty thousand plants. Of course, they have but few weeds to contend with, an important consideration, as they are in general suppressed by the peculiar soil and climatic conditions. I therefore could not help coming to the conclusion, that if these improvised plantations were placed under my control, I should re-plant them throughout. Anyhow it is important to be able to add that I found two notable exceptions to this crude style of planting, one of which having a few thousand plants, and the other fifty thousand, on both of which intelligent methods of planting had been adopted. And these two plantations, from a practical point of view, were decidedly encouraging. The seeds and huge cuttings or stumps were only four months planted. The seedlings in this time attained a height of from four to five feet, and they were exceedingly healthy and

vigorous. The huge cuttings are procured from the forest, that is to say, saplings in the forest are cut down and stuck into the cleared ground to form roots and permanent plants. These stumps measure from six to eight feet in length, both ends cut off, and in four months the vigorous shoots that spring from the tops are four and five feet in length, thus a continuity of growth from the sapling to the established tree.

This plant is an invaluable acquisition to rubber cultivators. It can be cultivated at a minimum cost consequent on its persistent tenacity and vigour as is exemplified in its native soil, and consequent on its other merits to which I have drawn attention. Further, it may be stated that this tree is comparable with particular products cultivated in the tropics and elsewhere, products that flourish in a great measure by the restricted cultivation given. That is to say, when we discover a region pre-eminently adapted for a given culture, there it yields not only the best produce of its kind, but also far more economically.

Again, the humble dimensions of the Manicoba tree, I am convinced, is a factor in its favour from a cultural point of view, for it attains to a size exactly suited for close planting. In the great *Hevea* (Para rubber) plantations under cultivation in the East, close planting is systematically resorted to with the object of forcing early crops which are available from young trees of limited size, for numbers collectively far more than compensate for the production of rubber per acre from full-grown trees widely planted. As a matter of fact, big trees are stated in the East to be an encumbrance.

The number of trees usually planted in the East run from 100 to 200 per acre, sometimes more. The number of Manicoba I advocate to be planted is 1,200. I estimate that 1,200 trees per acre (exclusive of certain returns in the fourth year) will yield 600 lbs. of rubber in the fifth year; and at least the same quantity annually thereafter for a long period of years. In many rich Manicoba zones I computed the number of wild trees at more than 100 per acre, some 25 per cent being tappable trees, most of the remainder saplings, the forest growth of which is

sluggish as compared with cultivation. It may be observed that a wild tree occasionally yields one pound of rubber at a tapping, *but the average is far less. One of the advantages, a subsidiary* advantage, to accrue from cultivation is that of systematic control of the cropping by a special staff of workers, for the itinerant collectors of wild rubber cannot always be counted upon.

I detected in the Manicoba forests several distinct varieties of this tree, and on enquiry I found that one particular variety was recognised as being richer in latex than others. The varieties are distinguished by colour, size, and lobe formation of the foliage which latter are remarkably vigorous in cultivated plants. The uncultivated trees are sparsely furnished with foliage. I have had considerable experience with regard to the effects of soil on rubber plants. Apart from the large plantation of *Virgen* rubber which I established in Columbia, I planted experimentally more than quarter of a century ago, both in Jamaica and in Columbia many plants of Ceara, a nearly related species of Manicoba. Furthermore, I introduced to Jamaica many plants of Para rubber, *Castilloa* and Virgen rubbers. Unfortunately, until recently, no attention has been paid to their propagation in that colony.

The *Hevea* (Para rubber) is indigenous to another part of Brazil. In addition to the boundless tracts of country throughout which it is dispersed, it is a large tree. It furnishes in a wild state most of the rubber found in commerce. But the natural resources of the forest gradually dwindle. This is the tree for cultural purposes that has claimed the attention of the capable planters of the East with far-reaching consequences. The species flourishes in conditions of soil and climate the converse of those requisite for the humble Manicoba tree. Hence, the latter species can never be cultivated side by side with its great Amazonian rival.

Supplementary to my foregoing account of this species of rubber, I think it is important to cite from, and append hereunto, an interesting article in the Kew Bulletin, No. 2, 1908, on this subject, which, *inter alia, contains much information supplied by* Mr. O'Sullivan Beare, H B M 's Consul at Bahia, to whom I had a letter of introduction from the Governor of Jamaica.

In the year 1906, Dr. Ule, a German botanist, who visited Bahia, named the Jequié Manicoba *Manihot dichotama.*

"The Jequié Manicoba is undoubtedly a new and distinct species of *Manihot*, and it must not be confounded with the *Manihot* of Ceareá *Manihot Glaziovii.*

"This discovery is a matter of much importance, not only to this State but also for the rubber trade in general, inasmuch as the rubber obtainable from the Jequié Manicoba when properly prepared, would seem to be equal in quality to the best product of the Para region.

"The season for extracting the latex from the Jequié Manicoba extends from August to March. The latex possesses the valuable property of coagulating spontaneously when exposed to the air, and it requires no acid or artificial coagulant of any kind.

A planter, established in the Jequié district, recently prepared a considerable quantity of rubber obtained from Manicoba trees growing wild in that neighbourhood, and despatched it to New York. The consignment was classified in the New York market as being equal to the best Para rubber, and it fetched one dollar twenty cents (5*s*.) per lb."

In addition to *Manihot dichotama*, two distinct and nearly related rubber-yielding species of Manicoba were found by Dr. Ule, "the one growing on the mountains of the right bank of the Rio San Francisco, and the other, confined to the country at some distance from the left bank, occurring especially in the adjoining State of Piauhy." . . . These two species are described under the names of *M. heptaphylla* and *M. piauhyensis.*

My examination of this species of rubber, *Manihot dichotama*, in its native habitat, set forth in my preceding account, shows that I am impressed with the remarkable possibilities of this rubber-yielding plant, thus having arrived at the conclusion that, under cultivation, it is destined to rank in productiveness, per acre, second to none. It therefore seems obvious that some confusion has arisen in the publication of a paragraph in the Kew Bulletin, wherein this species as regards its rubber-yielding capacities is undoubtedly misrepresented. A comparison is made with this

and the two other allied species, namely, *M. hetaphylla* and *M. piauhyensis.* In this comparison it is stated that the yield of rubber per tree under cultivation for the two latter actually exceeds the yield for *M. dichotama* five-fold? Thus, "the yield of rubber from a single tree of *M. dichotama* in one year can be reckoned at from 100-200 grammes." And, the annual yield of rubber for single trees of *M. piauhyensis* is from 500-1,000 grammes." Said paragraph is here subjoined.

"*Plantations.*—At present the plantations of *M. dichotama* are rather young and only the oldest are ready for tapping; but from the two other species, which have been known longer, a satisfactory amount of rubber is now being brought on to the market. In the plantations which are laid out in a quite primitive manner, the seeds are planted in rows 2 metres apart, making 2,500 trees to the hectare (2·47 acres). Other plants may be grown between the rows during the first year. With regard to tapping, *M. piauhyensis* is ready in the third year, and the other two species may be tapped in their fourth year of growth. The yield of rubber from a single tree of *M. dichotama* in one year can be reckoned at from 100-200 grammes with present methods, and this is equivalent to 200-300 kilogs. per hectare. The annual yield of rubber for single trees of *M. piauhyensis* and *M. heptaphylla* is from 500-1,000 grammes, which corresponds roughly, to about one tonne per hectare."

THE TIMBERS OF COMMERCE.

At the Carpenters' Hall, on the 18th March, 1909, Mr. H. J. Elwes, F.R.S., lectured on "Timbers of Commerce—Their Present and Possible Future Source of Supply." Sir Hugh Beevor, Bart., M.D., presided, and a large company was present.

Mr. Elwes said:—

When I consented to give a lecture on Timber to an audience which contains men whose avocations must have given them much better facilities than I have had to learn the uses of timber in many branches of industry, I hardly realised how difficult a task

I had undertaken. For though during my life I have had unusual opportunities of seeing the forests of many of the timber-producing countries of the world, and since the year 1900 have been specially occupied in studying the trees which have been or may be timber trees in Great Britain, I only now begin to understand how hard it is to acquire really accurate and up-to-date information on this question, and how much remains to be done before a work can be produced which will give to the users of home-grown and foreign timber the knowledge which they require. I have no hesitation in saying that for want of this knowledge large sums have been and still are annually wasted by landowners in planting trees of whose requirements they are ill-informed, on soils and in situations where, however ornamental, they can never be a source of profit; by architects, builders, manufacturers and artificers in using materials which are often not the best and cheapest for their respective purposes. I therefore propose to give a brief survey—and it must be very brief—of the principal sources from which we derive our existing supplies, and to consider how long they may possibly be expected to last, and what possible substitutes may be found for them when they become so scarce or dear that they can no longer be used profitably.

Five years ago I gave before the Surveyors' Institute a lecture on British timber, and did my best to call attention to the fact that there are several trees which have hitherto been ignored as timber-producing trees which can be grown to great perfection in this country; and I am happy to say that, owing to the great attention which has recently been given to scientific forestry, my efforts have already borne fruit in various ways. But whilst I am second to none in my desire to extend the planting of trees wherever they can profitably be grown, and to encourage the use of home products as much as possible, yet it is useless to blind oneself to the fact, of which a very wide knowledge of English trees has convinced me, that we cannot and never shall under any conditions which I can foresee in the future be able to compete with many other countries in the economical production of many sorts of timber now in general use.

Since I wrote this the report of the Royal Commission on Coast Erosion and Afforestation has been printed, and, though the evidence on which it is more or less based is not yet printed, a great deal of correspondence on it has appeared in the press, in which I have taken part. In the *Times* of February 8th I expressed an opinion very similar to what I have just said, and which has been strengthened by many letters from landowners and agents of experience, and especially by a very able article which appeared in the *Timber Trades Journal* of February 6th which I commend to your notice. Since then I have also read a very valuable pamphlet on "The Future Use of Land in the United States," by Raphael Zon (Circular 159, of the U. S. Department of Agriculture, 1909) and another on "The Lumber Cut of the United States in 1907," compiled by the U. S. Forest Service (Washington, 1908). I will not weary you with the mass of statistics which these papers contain but all my reading, like my own experience, convinces me that in Great Britain we can only expect to compete in economical production with a very few kinds of timber. These are chiefly hardwoods, which require a better class of land than that which the Commission proposes to acquire and afforest, and I would especially mention amongst them ash, sycamore, elm, poplar, and walnut.

Notwithstanding all that has been said and written by enthusiasts in forestry, and admitting that the soil and climate of Great Britain are in many parts exceptionally favourable to the growth of a great variety of timber trees, yet we are surrounded by so many economic, fiscal, legal and other difficulties that I am convinced that the afforestation of waste land and the profitable planting of trees on much of this land is a very uncertain speculation, and, as I said at the conference convened by Lord Carrington and Mr. Burns at the House of Lords two years ago, may be called gambling in futures of the most pronounced description. I say so because though we may and do grow some trees of as large a size and as good a quality as we can import, yet the land which is mostly available for the purpose cannot, however scientifically managed, compete with the virgin forests of the world in the better and more valuable classes of timber, even if the value of

timber is, as I believe it will be in the future, very much higher than it is at present.

Now, let me attempt a brief review of the principal sources of our timber imports and show what are the reasonable expectations of the future.

First comes the North of Europe, Sweden, Finland and Russia, from which at present something like 90 per cent of our ordinary building timber comes. This comprises, first, Scots pine (*Pinus silvestris*), known in the trade as red or yellow fir or deals, and spruce (*Picea excelsa*), known as white or Baltic whitewood or white deals. Neither of them are firs, which name should be confined to the numerous species of true firs (*Abies*), of which the timber of one only, the common silver fir, is little known or used in Great Britain. These two species cover millions of acres of land in a climate which makes agriculture impossible or only carried on to a small extent to supply the hardy woodmen who mainly live by timber, and who, owing to the remarkable facilities which exist for floating the logs from the forest to the saw-mill and the excellent organisation of an old-established industry, are able to land high-class timber in England at a lower price than we can grow it. I have little doubt that, though the size and age of the timber are diminishing, these forests will always continue to be the principal source of our supplies, for though many of them have been heavily cut over, yet the natural regeneration by seed wherever proper precautions are taken is so much more regular than in Great Britain that Nature alone does for them what it rarely will do for us. The same seems to apply to pitprops, which we can grow on waste land no doubt in sufficient quantity for our requirements, but profitably only when the cost of carriage from the forest to the mine is less than that of imported timber, and owing to differential railway rates and the want of water carriage, that only applies to limited areas in England.

Larch is another timber which at present comes in very limited quantities from the White Sea, but may come in larger quantities from the Petchora river when that great stream is more largely developed, but the shipping season from that river is so short and the difficulties of navigation so great, that I do not expect the

competition in this most profitable of trees to the British landowner will ever be so severe as in the case of pine and spruce.

From the countries adjoining the Mediterranean and Black Sea our timber imports are small as compared with those from Northern Europe, though important as regards oak. The oak which for high-class interior fittings, church decoration and carving has for a century or more under the name of Riga or wainscot oak been preferred by architects to native oak on account of its mild character, freedom from knots, and facility of working which endears it to the joiner, has been so heavily drawn upon that it is now scarce and dear, and becoming dearer. In consequence the majority of this oak now comes *viâ* the Adriatic ports from Sclavonia, or *viâ* the Danube and Odessa from Hungary, Roumania, and South-Western Russia. How long the supplies will last it is extremely difficult to foretell, especially as French timber merchants, foreseeing the scarcity of oak in their own country, have purchased large concessions, and the landed proprietors have, since new railways gave them an outlet, been selling their best timber very freely at prices which seem to leave them little or no profit. But when this is gone there is no oak-producing country which can supply the deficiency, and again the English consumer will have to fall back on home-grown timber or find a substitute. Of some of these substitutes I will speak later on.

Walnut is the next most important hard wood which comes from the Mediterranean and Black Sea ports. This is and always will be a high-priced timber, and from what I can learn is in Italy, Spain and France becoming scarcer and dearer. Our Southern, Eastern and Midland Counties, however, produce it of great size, and, though few architects are aware of it, of as good a quality as in the South of Europe.

Ash from Hungary and the Caucasus also comes to us in small quantity, and in some cases of most beautiful figure, and might be employed more largely for furniture if its beauty was better known. Olive-wood, box-wood and the knotted growths of the Mediterranean heath, largely used for pipes, are also imported from France, Circassia, and Corsica in small quantities.

Of coniferous timber, however, we get little, this class of wood being with one exception consumed locally. But the French Government in Algeria has lately offered for sale large quantities of a very fine and durable timber produced by the Algerian cedar (*Cedrus atlantica*). This so closely resembles the Lebanon cedar that it may be treated as a mere variety, and the wood as shown in the Algerian Court of the Franco-British Exhibition was certainly worth attention for decorating halls, passages, and large rooms, where its somewhat strong though fragrant smell would not be objected to.

In Northern Asia the extent of forest is immense, but owing to the practical impossibility of shipping the timber to Europe, there is no part of Siberia from which supplies may be expected except the extreme east, where the Amur river gives an outlet to a large tract of country covered with a great variety of different trees. Of these we have some botanical knowledge, and among them are both hardwoods and conifers which are likely to produce valuable timber, but we have no reliable information as to their existence in such quantities and in such situations that they can be exported at a profit, and having regard to the very long sea transport and the large demand for timber in China, it seems to me extremely doubtful whether Eastern Siberia can be ranked among the countries to which we may look for supplies in future.

Manchuria and Korea contain large forests, of which those on the Yalu river are now being worked on a large scale, and there is a valuable pine here (*Pinus mandschurica*) which may to some extent supply the growing deficiency of yellow pine from North America.

Though the immense population of Japan is mainly housed in wooden buildings, yet the valuable forests of the north and of the mountains of the interior have been so well conserved and economically managed, that there still exist large quantities of valuable timber trees, most of which have until quite recently remained unknown in Europe. No people have more taste or skill in woodwork than the Japanese, and many of the native timbers are of unusual beauty. Amongst those which seem to me most likely to be appreciated are the softwoods—sugi, or *Cryptomeria japonica*,

which for centuries has been cultivated with great skill; hinoki (*Cupressus obtusa*), which is surpassed by no coniferous timber in the fineness of its grain and the smoothness of its texture; hiba (*Thujopsis dolobrata*), which, however, owing to its slowness of growth and comparatively limited distribution, is not likely to be available in large quantity, and possibly some of the spruces and silver firs of Hokkaido, which, however, have no special peculiarities to distinguish them from other more accessible softwoods.

Among the hardwoods, however, there are several which are of unusual beauty and value. The best of these is an elm-like tree called keaki, *Zelkova keaki*, which rivals mahogany in figure and colour, and, as cabinet-makers have proved, equals it in those qualities which have made mahogany the most popular of all furniture woods. The quantity available, however, is insufficient to allow this timber to compete with mahogany in our market, and this is probably the case with others.

The wood of the *Cercidophyllum*, katsura in Japan, has been sold in England under the name of Japanese pine, on account of its being thought likely to be used in place of yellow pine for some purposes; but, as it has not the least relation to any kind of pine, it seems to me that katsura is not a more impossible name to use in trade than mahogany.

Passing to Southern Asia and Malayana, whose tropical forests produce innumerable timbers of value, some of which will, when better known and exploited on a larger scale, prove very valuable, we find very few which have established a firm position. Teak is of the most importance, but as it mostly comes from the interior forests of Burmah, Siam and Java, whence the cost of transit is considerable, and as the forests in the past have been heavily thinned, the price of this almost indispensable timber is high and rising. When, however, the virgin forests of Borneo, Sumatra, and the Philippines come to be thoroughly explored, and the same methods which have been adopted for the transport of mahogany in the West Indies and Africa are used, I see no reason why large supplies of new hardwoods of similar character should not be found. Already, since the United States have made incomplete

surveys of the timber resources of the Philippine Islands, a great number of valuable woods have been discovered, but the risk and expense of such commercial ventures seem to deter speculation at present, and it is impossible to say what may be the future of these vast regions from this point of view.

The Andaman Islands produce some valuable woods of great beauty, among which padouk has been extensively tried, but neither its colour, which fades on exposure, nor its capacity for holding high polish, leads me to think that it will have a great future so long as mahogany can be imported in quantity at a reasonable price.

India, whose timbers are better known than those of any other tropical country, owing to the researches of our Forest Department, and especially to Mr. Gamble's admirable work on Indian timbers, though producing many fine woods, sends us little or nothing beyond a few fancy woods, such as rosewood, ebony, and satinwood.

We now come to North America, which for a century has been next to Northern Europe, the source of our largest imports; but the virgin forests which formerly covered the greater part of the United States have been in the last half-century so recklessly exploited, usually without the slightest regard to the future, and the losses by fire have been so great that, though in the last decade a Forest Department of unrivalled ability has been created, and steps have been taken to awaken the people of the United States to the imminence of a timber famine, it is certain that some of the most valuable trees are approaching exhaustion, and that many others which are being used as substitutes are rapidly rising in price. Having visited the United States four times, and paid particular attention for some years past to this question, I cannot admit that the failure of this source of supply is so imminent as many writers have prophesied. I believe, on the other hand, that the great efforts which have been made by some of the most able writers and public men—among whom President Roosevelt, Professor C. S. Sargent, and Mr. Gifford Pinchot, Chief of the U. S. Forest Bureau, are pre-eminent—to protect the existing forests,

and to instruct the people on the reproduction of existing woodlands and the planting of valuable trees, have produced so great an effect that we shall always be able to procure supplies of great importance both from the United States and Canada, which have now seen the necessity of similar measures of protection and conservation.

I am not going to weary you to-night with statistics, which may be got to prove anything, and, as a rule, statistics of forest products are from their nature more difficult to make accurately than any others. But the United States Forestry Bureau have just issued what seems to me a very carefully compiled estimate of the lumber production of the U.S.A. during the year 1907, which is the largest ever recorded, and, dividing board-measure by ten, to reduce it approximately to cubic feet, it amounts to more than 40 billions of cubic feet, valued at the place of production at over 700 million dollars. In 1850 it was only 5 billions; in 1860, 8 billions; in 1870, 13 billions; in 1880, 18 billions; in 1890, 23½ billions; in 1900, 35 billions. It has thus nearly doubled in seven years; and, what is even more remarkable, notwithstanding the great increase in the use of substitutes for wood, such as cement, concrete, and steel, the annual consumption per head has risen in the United States from 215 board feet in 1850 to 470 board feet in 1907, though the average value has increased very much since 1900.

Of the woods best known to us, walnut, hickory, cedar, and ash are all very low in quality and high in price; while oak, yellow poplar, and white pine have also risen rapidly in value, and, with the exception of Douglas fir, none of them are likely to satisfy the demands which are being made for home use for many years longer. Of all these woods, maple, birch, and spruce are the only kinds much used here which Canada can supply in large quantity.

Let us consider the most valuable timbers in detail. Among the softwoods we have white pine, known here as Weymouth, and among timber merchants as yellow pine (*P. strobus*), once the first of all American softwoods, now becoming so comparatively scarce that the best qualities are worth four to six shillings per cubic foot, and in consequence are little used for ordinary purposes. Pitch

pine, known in America as long-leaf pine (*P. palustris*); this formerly covered a great part of the coast region of the southern Atlantic States, but has suffered more from reckless felling, tapping for resin and fire than any other tree. The future production and price of this is very difficult to prophesy, but there seems to be no other conifer existing in quantity and possessing all its good qualities which can take its place, and its price must certainly rise very considerably in the near future.

There are several other pines in the Eastern States known under various names, which are more or less confused in this country with true pitch pine, and which in the aggregate form the principal building timbers of all the United States. The principal of these is the *Pinus echimatus* of Miller (*P. mitis*, Michaux), commonly known in America as short-leaf or yellow pine, and imported to some extent mixed with other species as Carolina, or North Carolina pine. The short-leaf pine covers immense areas west of the Mississippi, and, though inferior in strength and durability to long-leaf pine, and not so suitable for many of the purposes for which that is used here, is likely to be mistaken for the latter if the port of shipment is not disclosed, and as there are other species growing in the area which supplies both long and short-leaved pines, it seems highly desirable that importers should come to some understanding as to the names to be used in the trade.

Spruce, mostly the produce of *Picea nigra* and *Picea alba*, covers enormous areas in Canada and some of the New England States, and forms an important article of trade to the western ports of England, Scotland and Ireland, where it takes the place of Baltic spruce. Though the consumption has been immense since it has been the principal wood used for making paper pulp, yet, judging from the opinions expressed by forestry experts in Canada, there is enough to maintain the existing demand for ever, on account of its good natural reproduction and the unsuitability of most of its area for agriculture.

Louisiana or red cypress (*Taxodium distichum*), a tree which covers large areas of swampy ground in the Lower Mississippi,

which, though long known and used locally in preference to other woods on account of its extraordinary resistance to decay, has only in recent years been exported to New England and European markets. Its valuable qualities are as yet little known to architects and horticultural builders, but at the moderate price at which it can be obtained, it is well worthy their attention, and the board which I exhibit also proves that selected wood shows a very ornamental figure.

The American hardwoods best known in the trade here are oak, produced by many different species, but mostly sold as white oak and red oak. The consumption, especially for railway sleepers, has been so great, and the destruction of the accessible forest so rapid, that it cannot be much longer exported at anything like the present price, and this should be one of the greatest inducements to English landowners not to sacrifice their valuable timber at anything like the low prices now prevalent, for, though iron has taken its place for shipbuilding, and to some extent for railway cars, yet a time must come when this wood will be more valuable on account of its great strength and durability. It is impossible for me in the time at my disposal to even mention the numerous varieties of oak and timbers sold under the name of oak or which have the properties of oak, which are or may be in competition with it. But all the experience of shipbuilders, wagon and car-builders seems to prove that it is and will remain a necessary timber for innumerable purposes. I am informed by cask and vat-makers that foreign oak is unsuitable for their trade on account of its greater porosity, which taints the casks in a way that is not the case when our harder home-grown timber is used.

Next to oak, black walnut (*Juglans nigra*) stands among American hardwoods as the best for furniture making, and has always commanded a higher price than any timber found in the United States. Though still imported in considerable quantities, the size and quality of the timber are falling off on account of the fact that it is nearly exhausted; and though this tree is being largely planted in many parts of the United States, Europe, and

England, a century at least must elapse before these trees can be large enough to again produce large supplies. The timber of the tulip tree (*Liriodendron tulipifera*) known in America as poplar, or yellow poplar, and here as whitewood, or canary whitewood, has of late become one of the most favourite woods among manufacturers of furniture, as it is imported in very wide boards at a moderate price; and though the failure of this species is not so imminent as that of black walnut, there is no doubt that the price is increasing, and will still more increase, as the forests where it grows become more depleted and inaccessible.

Another wood known here as satin walnut, and in America as red gum, produced by a tree called *Liquidambar styracifolia*, is also of late years an important source of supply to cheap furniture makers, and has attained notoriety, owing to its having been used for paving. No better instance could be given of the great loss and expense which may arise from imperfect knowledge of timbers.

Birch is another wood, mostly produced in Canada and the North-eastern States, which has formed a substitute for beech to our furniture manufacturers; its cheapness and the freedom from waste in cutting up have made it very popular, and when figured, as in some varieties, it is sometimes difficult to distinguish by its colour and grain from satinwood. I believe, though I cannot prove, that many pieces of furniture sold as satinwood and believed by the dealers to be really such, are in fact veneered, wholly or partly, with this figured birch wood.

Besides the above-named there are many hardwoods, such as hickory, used for shafts and tool handles. Black cherry is a valuable furniture wood now becoming very scarce, and sage, orange, or bowwood, is likely, if it can be procured in sufficient quantity, to be a valuable wood for motor wheel spokes, which are more or less known in commerce; but the American ash, supposed to be the wood of the white ash, (*Fraxinus americana*), which is often mixed with the timber of other species of ash, is a competitor with our English ash. Though for many years it has been used for the heavy oars of the Navy, it has been so largely cut in Canada

and the Eastern States generally that our supplies now principally come from the Mississippi Valley, and are likely to fail within a not distant period. This seems to point to the importance of increasing the quantity of ash in Great Britain, which is admitted by all practical men to be at least equal to, if not superior to, any foreign ash, and is in my experience the most profitable hardwood to landowners.

Canadian elm (*Almus racemosa*), often known as rock elm, is a wood which has been long used by ship and boat-builders on account of its peculiar value for gunwales, gratings, and other deck fittings. Twelve years ago Sargent spoke of it as being threatened with extinction, but a small quantity is still imported in the form of hewn logs a foot or more square at increasing prices. I have little doubt that we could produce as good or nearly as good timber from some of the varieties of elm if, instead of growing them as hedgerow timber, we crowded them in woods where the branches could not develop. But there is no tree of which the different varieties and timber qualities are so little understood both by planters and timber merchants in England, and I venture to predict that if properly selected and managed, elm is a tree which may be more profitably grown in England than it is at present.

Passing to the Pacific coast of North America, we find several timbers which, on account of their immense size, facility of transport, and valuable qualities, have been attracting great attention all over the world, and are largely exported not only to Europe, but also to China, Australia, and South America.

Among these the Douglas fir, commonly known as Oregon pine, is the most important. Though the quantity felled is enormous, and the waste in the forest by fire and recklessness and bad laws are even greater, yet the remaining forests are so vast and the reproduction so rapid that, though we may not in the future be able to receive it in as large dimensions and of as fine quality as at present, I anticipate that the forests of Washington and British Columbia will, under better management, continue to produce large supplies for an indefinite period. This, however, depends largely

on legislation, for if the British Columbian Government does not quickly realise the position it may be too late to save the forests.

The rapid growth of Douglas fir in some parts of Great Britain and Europe may supply useful timber in the future, but can never compete in quality with that of imported timber, which has taken 200 to 300 years to grow in the virgin forests, and which represents, like most of our imported timber, only the pick of the best trees.

Redwood is another valuable timber found along the coast of Northern California. It has never attained the same popularity that it has in its native country, and though its extinction is not so imminent as that of its congener, the *Wellingtonia*, it cannot be regarded as likely to supply a large export to this country.

Time does not allow me to say as much of their valuable qualities as I should like to do, but the specimens exhibited will give you some idea of them. Though there are several other softwoods produced of large size and in considerable quantity on the Pacific Coast, among which Menzies or silka spruce, white and noble fir (*Abies grandis* and *Abies nobilis*) are the most remarkable, none of them seem to be as important as those last mentioned, and there are no hardwoods in sufficient quantity to export, though Oregon maple (*Acer macrophyllum*) and myrtle (*Umbellulana californica*) produce wood of handsome figure which is locally used for furniture.

From the West Indies and Central America mahogany has long been the most valuable and important wood in the market. The trees which produce the various timbers known as mahogany are so numerous, especially in West Africa, that I shall not now attempt to speak of them, especially as Mr. A. Howard has so recently given you a lecture in which he dealt largely with mahogany. Moreover, I have not yet had the opportunity of seeing these tropical woods in their native forest, except to a very small extent in Mexico, and so far as I know there is no available information which will enable anyone to forecast the probable supplies of the future from this region.

It is more than probable that the vast forests of Guiana, the Lower Amazon, and Brazil may for ever be able to supply all we need when better known, and more accessible regions are exhausted. It seems to me merely a question of price, and this depends on the local cost of labour and transport.

Africa has of late years sent us immense quantities of so-called mahogany and small supplies of other woods, of which for the most part so little is known that it would be useless for me to speak of them. Madagascar is also full of beautiful timbers, which the French are doing something to exploit, but I know too little of them to tell you anything worth hearing, and I do not think that anyone who has not personally visited the country can do so.

South Africa never was and probably never will be able to supply its own demands, and I am not aware that any kind has ever been exported from its scanty forests. If the country continues to grow it may be in future a competitor with England for soft-woods of North Europe, which now supplies most of its mining and building timber, and for the hard-woods of Australia and the eastern tropics.

You may now ask why I say nothing about the timbers of Australia and New Zealand and Tasmania, many of which are now being imported in large quantities, and some, like jarrah and karri, have already established an important position for street paving and other purposes. It seems to me presumptuous for anyone who has not studied these timbers on the spot to speak of them with real authority, and this I have not yet had time to do personally. A whole evening would be required to do fair justice to the numerous species of trees which are found there, and I have but a few minutes left.

All I will say is that, judging from what I hear and read, the forests are disappearing almost as fast as in North America, and the supplies available in the future seem likely to be required for the rapidly increasing population of these great colonies.

I must, however, mention one species (*Eucalyptus globulus*) from Tasmania, which has been very largely used for piles in the

Admiralty harbour works at Dover, and has been found, on account of its great size, strength, weight, durability under water, and resistance to the attacks of marine insects, superior to any other timber. Whether the supply is likely to last I cannot hear, as I can find no reliable estimates as to the quantity of timber left in any of the Australian Colonies.

Now that I have tried to show you how much we have to learn about timber, both from a scientific and an economic point of view, I will make an appeal to this company and to other wealthy companies and citizens of London to assist in a work which has never yet been properly attempted in England. I allude to the Museum of Forestry and Forest Products which it is proposed to erect at Cambridge as soon as the necessary funds can be collected.

The University of Cambridge have taken the lead in appointing a gentleman to reside and lecture on forestry, and they have agreed to find a suitable site for building a museum, of which the sketch I show may give some idea.

The idea is that it should be entirely constructed of timber, and that every piece of wood used in the structure and in the floor, roof, interior fittings, walls, doors, desks, bookcases and cabinets shall be in itself a specimen of known origin, which may serve to illustrate the fitness of every kind of commercial timber for the purpose to which it is applied. It is true that you may see many of our finest colonial and foreign timbers in the museums of Kew, in the form of logs and boards, but there is no institution in Great Britain to which architects, builders, and users of wood generally can go to get accurate and complete knowledge, and where they can see what they will be able to see if this idea is carried out. A gentleman (Mr. Burdon) has been already appointed to study and lecture on wood, and specimens are pouring in from many quarters; but for want of space to house them they cannot be properly utilised, and, as you no doubt know very well, the University as such has no funds to spare for the endowment of new branches of study. Thanks to the munificence of the Drapers' Company, an agricultural museum, lecture-room,

and library have just been commenced, and I venture to say that the need for a forestry museum is even greater, because so much less is known of this branch of agriculture.

I am only asking you, gentlemen, to do what I have done. I have no hesitation in saying that this money will not be wasted, and that the knowledge it will make available both to students at Cambridge and to the public generally will fully repay even a larger expenditure than we anticipate.—(*Timber Trades Journal.*)

SCOTTISH AFFORESTATION.

BY JOHN NISBET.

During the last twenty-five years four Committees and Commissions have dealt with Forestry in the United Kingdom. In 1887, a Select Committee of the House of Commons recommended the establishment of a Forest Board and Forest Schools, and pointed out that, apart from any immediate pecuniary benefits, there would be considerable social and economical advantages in an extensive system of planting in many parts of the kingdom, especially on the west side of Ireland and in the Highlands of Scotland. But no action was taken.

In 1902 a Departmental Committee of the Board of Agriculture inquired into and reported on the present position and future prospects of forestry, and the planting and management of woodlands in Great Britain. They urged immediate provision for bringing systematised instruction within the reach of owners, agents, foresters, and woodmen; recommended that assistance should be looked for from local authorities, societies, and individuals interested in forestry and technical education; and recommended that Government should compile a statement of areas suitable for afforestation in Great Britain; but they expressly *refrained from advocating any general scheme of State forests under* present circumstances. Regarding the drawbacks to private planting, the Committee made no recommendation about the incidence of local rates on plantations and the assessed valuation of woodlands, but thought that claims for the extraordinary traffic made

against timber merchants (and therefore actually paid by the timber-growers) were unreasonable; that the estate duties must both act as a bar to afforestation in districts most needing it, and compel the realisation of immature timber, thus preventing the practice of sound forestry; that security was needed against fire from railway sparks (since very inadequately provided up to a maximum compensation of £100 under the Railway Fires Act, 1905); and that an owner of plantations who keeps down ground game should have the right to recover compensation for damage caused by hares and rabbits from adjoining property. Very little action was taken on this Report. One of the most important recommendations, that concerning the detailed inspection and scheduling of land suitable for profitable planting (which must, of course, be a step taken before any practical scheme of very extensive planting can be properly considered), was altogether ignored. In October, 1907, a Departmental Committee of the Board of Agriculture in Ireland advised regarding an extensive scheme of forestry operations. This Committee's Report, issued in April, 1908-09, is the most business-like afforestation scheme that has as yet been suggested for any part of the United Kingdom. It recommended the acquisition of sufficient land (including some of the existing 300,000 acres of woodland) to provide about 700,000 acres of new woods and plantations, of which 200,000 acres should be State forests in large blocks and 500,000 acres smaller areas under County Councils or in private ownership.

The fourth and last inquiry was instituted when the Royal Commission on Coast Erosion was enlarged, and ordered to report whether it is desirable to make an experiment in afforestation as a means of increasing employment during periods of depression in the labour market; and, if so, how such experiments can best be conducted. On 4th January, 1909, they recommended the afforestation and planting of 9,000,000 acres, mostly grazing land at present, within the next sixty years, at a rate of 150,000 acres a year, and at a cost of £13 6*s*. 8*d*. per acre (£6 13*s*. 4*d*. being for the freehold, and £6 13*s*. 4*d*. for the expenses of afforestation), or £2,000,000 annually.

This Royal Commission estimated that 6,000,000 acres of plantable land are obtainable in Scotland. But the land area of Scotland is only 19,069,770 acres, and it is absurd to suppose that about one-third of the total area of Scotland is plantable with profit. Over 3½ million acres are above the 1,500 feet contour; and to assert that nearly two-fifths of all the rest is waste land or poor pasture plantable with profit must seem equally unreasonable. Even in sheltered localities timber-growing seldom proves profitable at 1,000 feet; and if all the land above that elevation be subtracted, then it will be found that 6,000,000 acres far exceeds any rational proportion of the remaining land less suitable for agriculture than for forestry. And as most of the hill land below 1,000 to 1,200 feet form winter pasture for sheep stocks, if that be taken for afforestation, the whole of the Highland grazing industry would be dislocated.

As regards afforestation affording suitable work for the unemployed, the Commission had "no hesitation in asserting that there are in the United Kingdom at any time, and specially in winter, thousands of men out of work for longer or shorter periods, who are quite ready and able to perform this or the higher class of labour." But this opinion is opposed to that of the Irish Forestry Committee, who were unanimous in stating that afforestation would not prove a direct remedy for chronic unemployment, though they pointed out that any extensive scheme of planting must indirectly help to ameliorate the condition of the working classes. Our planting season is from autumn to spring and while the formation, tending, and harvesting of timber-crops, will increase the amount of employment given to the rural population, planting work on wind-swept waste land in autumn and spring cannot be suitable for the elderly, the weakly, and the least skilful and energetic who are always the first to be thrown out of work and the last to become re-employed in our large cities. Unquestionably, any and all extensive plantations would give work to the rural population, and would bring great and almost immediate advantage to agriculture, especially to stock-raising on wind-swept moors and hillsides; and ultimately the handling, transport, and

conversion of the timber-crops, and the timber itself as a raw material for many industries, would circulate a very large total amount of money throughout the British Isles. On the average a 60-year old wood should yield about 100 tons weight of timber per acre; and the felling, logging, transport, conversion, and distribution of such woodland produce will, of course, add directly and largely to the total amount of wages that would then be payable to labourers and workmen in this country, in place of being sent to foreign countries, as is at present the case. Thus even if only 600,000 acres are afforested (instead of the 6,000,000 acres in Scotland which the Royal Commission recommended to be bought and planted), that would mean an annual fall of about 1,000,000 tons deadweight to be felled, transported, and distributed in this country. Indeed, there is hardly any branch of industry which would not benefit largely by our having extensive woodlands, and this obvious advantage ought to commend timber-planting to our national business instincts. Certainly, with the world's constantly increasing demand for wood, and its constantly decreasing supply, well-formed plantations ought to prove a sound and remunerative investment if made prudently, and on a large scale.

The serious position of Britain with regard to timber is perhaps hardly as yet realised generally. The value of our annual timber imports ranks next to those of cotton, wool, and grain. But during the last twenty-five years our timber import bill has risen by 60 per cent., while our population has only increased by 20 per cent. And the price of timber is soon likely to rise at a much higher rate. Apart from all other timber, in 1907, our imports of rough-hewn pitwood came to 2,627,209 loads, valued at £3,049,484, while those of wood-pulp came to 672,499 tons, valued at £3,312,347. These two items alone amounted to £6,361,831, and exceeded in value the similar imports of any previous year. And last year, a year of great commercial depression, our imports of pitwood and wood-pulp were far larger than ever before, increasing respectively by £530,000 and £313,000, or £843,000 in all, over the previous highest record in 1907.

	Year.	Loads.	Value.
Hewn Pitprops or Pitwood	1906	2,451,665	£2,713,005
" " "	1907	2,627,209	3,049,484
" " "	1908	3,041,440	3,579,355
	Year.	Tons.	Value.
Wood-pulp	1906	606,811	£2,915,209
"	1907	672,499	3,312,347
"	1908	748,419	3,625,803
		Year.	Value.
Combined value of Pitwood and Wood-pulp alone ...		1906	£5,628,214
" " " " " " ...		1907	6,361,831
" " " " " " ...		1908	7,205,158

The total value of our wood and timber imports was *£27,507,410 in 1906, £27,093,054 in 1907, and £24,306,059 in the* depressed year of 1908. Of this total £18,534,958 in 1906, *£17,146,823 in* 1907, and *£14,515,433 in 1908*, were for wood "sawn or split, planed or dressed," and at least one-third of this amount represents wages paid to foreign workmen (in addition to the ordinary cost of extraction from the forests), a great part of which might be retained for our own workmen if we had the necessary woodlands providing the raw material to operate upon.

To supply these pitwood and pulp-wood demands alone, without making any provision for future increase with increasing population, would need the annual fall from about 3,000,000 acres of conifer and other woodlands—that is to say, an annual cut of about 60,000 acres of woods worked with a 50-years' rotation, or of 50,000 acres of woods worked on a 60-years' rotation; and the satisfaction of the future demands for pitwood is surely one of the most important matters connected with afforestation in the United Kingdom. In coming years the supply of pitwood to British coal mines is likely to cost more; and whatever thus tends to raise the price of working coal must at the same time influence all our industries dependent on coal as part of their raw material for producing commercial articles. The wood-pulp industry (hardly existing in Britain, and now only on foreign wood) is capable of enormous expansion, given sufficient supplies of soft woods; and it is an industry that would spring up in rural districts wherever such raw material could be supplied in large enough quantities.

If our Scottish waste lands and poor pastures are at all plantable with profit, it will be in coniferous crops that the best returns must be sought. Such crops are the most likely to thrive on poor land, cost least to establish, and give the quickest returns. Our soil and our climate are well suited for the growth of all kinds of timber, both hard and soft. British Oak, Beech, and Ash are known to be better than Continental or American kinds; and improved methods of planting and tending, and more systematic management are all that is needed to make the coniferous timber that may be grown in Scotland equal or superior to the similar class of wood which we now import from the Baltic. Some of the tallest and biggest Larch I have ever seen are growing in the South-west of Scotland (Dumfriesshire), and the following details regarding the growth of Conifers in woodlands will show how well our soil and climate suit them :—*At Barcaldine* (*10 miles from Oban*) are to be found in the Princess Louise plantations of 1871 (now thirty-eight years old), in fair canopy—Spruce, from 40 inches up to 52 inches girth, and over 60 feet high, on very wet peat land, well drained; Larch on drier ground (1871), up to 48 inches and even 50 inches girth, and 70 feet high; and Scots Pine (1871), up to 44 inches and about 50 feet high; but not nearly so well grown as the Spruce or Larch. Douglas Fir (1866), in semi-canopy, 7½ feet and 8⅓ feet girth, and over 70 feet high. In the open park, Silver Fir, 16 feet girth, and about 100 feet high, and Spruce, 11 feet girth, and about 90 feet high. In another plantation Spruce (1871), up to 52 inches girth on very wet peat, well drained; and Larch, on slightly higher ground, up to 45 inches. In an older plantation, on higher ground (but also wet peat, well drained), Spruce girths up to 6 feet, and Scots Pine up to 5 feet. On neighbouring dry knolls the Larch growing among Oak and Beech girth up to 6½ feet, and are very well grown; while there are also fine Spruce and Silver Fir.

The three essentials to any Scottish afforestation scheme are (1) Money, (2) Land, and (3) Labour and Supervision. Certainly, no great amount of planting can take place anywhere unless funds are made available, and probably the only way in which money can be raised as required will be to form a " National Afforestation

Fund," by issuing guaranteed 2¾ per cent. stock for the amount needed while planting continues. Although under existing conditions the State alone can afford to create large compact blocks of woodland without desiring quick returns, yet a vast State monopoly of timber-growing can only be justified after the failure of fair attempts at assisting and encouraging private landowners. Private timber-planting is at present prevented by want of funds, oppressive legislation, heavy financial burdens, want of systematic management, and over-preservation of game (especially ground game). But these drawbacks can be remedied; and till private landowners have been found unwilling to agree to reasonable proposals when made by the Government, there seems no justification for the compulsory expropriation of all the land suitable for planting in Scotland, as recommended by the Royal Commission, which further stated that—"In no circumstances do your Commissioners suggest that the State should be expected to finance schemes of private afforestation, by way of loan or otherwise. The security would not, in their opinion, in such cases, be of a sufficiently substantial kind to warrant such action." Here the fact was overlooked that in both France and Germany the great bulk of the woodlands is in private or in corporate ownership:—

	France.	Germany.
	Acres.	Acres.
Woodland area	23,400,000	34,730,000
Percentage of Woodlands owned by:—	Per cent.	Per cent.
State and Crown	11	33
Private landowners	66½	47½
Church lands and other endowments, municipalities, village communals, and corporations.	22½	19½

So far as land is concerned, if the State desires to obtain large areas for planting, many hundreds of thousands of fairly good plantable land can easily be acquired in all probability at an

average cost of from £2 to £3 an acre (including the sheep acclimatisation value). But even supposing that all the necessary money and land could be provided, the question of Labour and Supervision would still be perhaps the most serious of all. The men who are to work in the woods must be healthy and thoroughly acclimatised to the severe weather conditions of our western coast and our Highland hills. Acclimatisation is just as much needed for the human beings concerned as for the sheep on Highland farms; and this point should never be lost sight of when considering the question of the labour needed for planting, tending, and harvesting woodland crops on our hillsides and along the slopes near our seashores. Hence the question of small holdings and forestry dovetail into each other, and cannot be properly considered apart from each other. Already, in Argyllshire, planters and nursery hands receive 3*s.* 4*d.* a day, and suitable men are scarce.

Undoubtedly, the problems of Congestion, Small Holdings, and Afforestation must go together in Scotland. Without national afforestation to eke out a livelihood, small holdings will never pay; and without the local labour that small holdings would provide, the proper working of large woodlands will be practically impossible. For a great national scheme of planting, a large number of well-trained practical foresters will also be required, and such training has not yet been organised to meet the demand that would then be made for men of this class. Within the last five years small schools for practical foresters have been formed at the Forest of Dean for England and Wales, and at Avondale (Co. Wicklow), for Ireland; but as yet no such school has been established in Scotland; and the only places at which more or less systematic outdoor instruction in woodland work is here given are on some few private estates, where much has been done to advance the education of forest apprentices.

So far as any practical step has been taken, all that has yet been done by the State for Scottish afforestation was to sanction the purchase of the Crown estate of Inverliever (Argyllshire, bought for £25,000), where planting is to begin this autumn, though only 150 acres a year are to be planted during the next twelve

years. This is a very poor beginning. As the Chancellor of the Exchequer has previously said, he was alarmed at the Royal Commission's proposals, and was determined to confine operations to experiments at first—the funds and machinery for which are to be provided through the Development Bill now under the consideration of Parliament. At the second reading of this Bill, on September 6th, 1909, the following interesting discussion took place:—

Mr. Munro Ferguson, said the Advisory Committee, if it was a body which carried with it public confidence, would be simply a filter through which these demands from the country would go to the Treasury. A body of this kind ought to be able to round off some of the over-lapping that now went on, especially in regard to forestry and agriculture. That was why he thought this Advisory Committee would be a security for economy rather than for extravagance. If a start was to be made with afforestation there must be some provision of this kind. For the next eight or ten years he believed, they would have to spend £100,000 or £150,000 a year in carrying out the preliminaries of any considerable scheme of State afforestation. No money could be more usefully spent. In Scotland there was a very large area that might be afforested to great advantage. But he did not think it should be assumed that the State should do everything. The State would have to do a great part of the work, but individual landowners would have to do their share also.

The Chancellor of the Exchequer said that as to great schemes of afforestation, he agreed with Mr. Munro Ferguson that the first thing to do was to have experiments in order to see what could be done, and what could not be done in this country. That was all the Government proposed.

We now know what is the most we can at present expect from Government in the way of direct State afforestation. But as a complement to this Development Bill, suitable machinery for the improvement and extension of Forestry in Scotland is being provided in the Board of Agriculture (Scotland) Bill, which was introduced into the House of Lords on September 13th, 1909, and which, it is hoped, may be re-introduced into the House of Commons and become enacted next session. Under this Bill, ample powers are proposed for the organisation and effective administration of a Scottish Department that will be able to utilise to the best advantage of Agriculture, Forestry, and other rural industries, all the funds which may become available for such purposes under the

Development Bill, and by supplies directly voted by Parliament from year to year.

The fate of Scottish forestry seems to be bound up with these Government measures; and it is to be hoped that, if they be passed, whatever funds then become available may be wisely expended, so that some later Government, years hence, when the initial experiments have proved successful, may feel justified in giving this very important question further and more favourable consideration.

NEW FIBRES FOR PAPER.

BY WILLIAM RAITT.

The scarcity of paper-making material, which keen observers have seen approaching for many years, is now an accepted fact. The position can perhaps be best indicated by quoting the remarks of Lord Northcliffe, the Chairman of the great Harmsworth group of publishing enterprises, at a recent meeting of his shareholders.

"It is no secret that the whole world that lives by paper and print is clouded by the imminent approach of a rise in the price of paper. I have just seen a list of newspapers in the United States that have been obliged to double their price, and another list of those that, instead of doubling their price, have reduced their size. This rise in price of our raw material, we know to be chiefly owing to the depletion of the world's supply of the spruce tree from which this class of paper is made. This augmentation in the price of paper is caused by the scarcity of a material that takes at least thirty years to grow, and is a much more serious form of famine than that where an article is concerned which can be grown in a year or two."

The "world that lives by paper and print" is therefore once again face to face with a recurrence of what has ever been its chief difficulty—the sufficiency and permanence of an adequate supply of raw material. The last crisis of the kind was about 1875 when the rapidly-growing requirements outran the supply of Esparto, which for twenty years previously had been the staple material for print

and newspaper. Woodpulp arrived just in time to save the situation. It introduced a supply so plentiful and so cheap that it seemed as if at last an inexhaustible source had been tapped, and but few foresaw the inevitable result of cheapness plus the rapidly growing demand of education and culture, upon an article which, as Lord Northcliffe remarks, takes at least thirty years to produce. Woodpulp brought the cost of ordinary newspaper down from 5 pence per pound in 1870 to a penny farthing in 1900. At the same time an enormous increase in the reading public was taking place. The combined result is that whereas in 1870 the world's annual product of paper was about two million tons, it is now eight millions, and is growing at the rate of 25 per cent every ten years. Of this eight millions, six and a half is produced from wood. Such an enormous advance on the modest requirements of forty years ago has had simply disastrous effects on the forests of Northern Europe and America. Whole countries, whole States, have gone galloping down the insatiable maw of the cheap press, until we have now arrived at this state of affairs :—In the U. S. A. exhaustion so complete that the mills there are now importing supplies of wood from Canada, at a cost of 50 per cent to 70 per cent in advance of values prevailing when they had forests of their own to draw from. In Canada there is still plenty of wood in the back blocks, which Canada means to keep, having taken warning in time from the fate of her neighbour, and she has embarked on a restrictive policy which aims at reserving her forests for future timber supply rather than for present paper supply. In Northern Europe, deforestation so huge, that forests are now at great distances from mills and ports, with consequent scarcity and increase of cost, and (as a bye-product of this destruction) a great falling off in the water-power with which they manufacture the pulp. For the present, the net result *is a stoppage of expansion, a scarcity of supply and a rise in price.* For the future, it means a condition of positive famine, with a tremendous curtailment of publishing enterprise, unless a new source of raw material speedily makes itself manifest. Nothing further can be hoped from wood. It has reached its limit, and the nations of the world will rise up in wrath against any attempt to

further rob them of one of their most valuable reserves of capital wealth.

Much disappointment has been caused in the past by a too literal acceptation of the statement that paper can be made from any vegetable fibre. So it can, but money can't. To make both, several important facts must be ever before the fibre prospector. Paper is cheap, must be cheap to fulfil its purpose. Any serious increase in cost can only check its utility and curtail its production. To secure the necessary cheapness, it can only be made from waste—from that which has no value for any other purpose whatsoever. Waste may be either artificial, as with rags, or natural. My definition of natural waste suitable for paper-making is as follows:—The fibre or plant from which it is to be extracted must be a free gift of nature, growing and reproducing itself naturally and without cultivation, must not be of any value to the spinner, rope-maker or even (to any competitive extent at least) to the feeder of cattle; and its removal from place of growth must not imply an attack upon any form of permanent capital wealth. In the early days of woodpulp, the wood from which it was made no doubt fulfilled some of these requirements. It is because it did not answer to them all that it has failed to prove a permanent source of supply.

I have spent some years in investigation and experiment on this subject, and have no hesitation in declaring that South-Eastern Asia, including India and Ceylon, is in a better position to deal with this question than any other part of the world, inasmuch as in these regions is to be found a great store of the wild fibrous grasses which best fill the above requirements, together with the cheap labour required to collect them. Bamboo alone is capable of supplying tens of millions of tons annually without injury to its permanence or reproduction. By what is known as the acid process it yields an excellent pulp for news or cheap book paper, and at a cost considerably below that of wood. Almost at our doors, in Japan, there is a market for 20,000 tons of it annually which is now supplied from Europe at a great cost for freight. My own investigations indicate that in average bamboo jungle, a well regulated system of cropping will yield 5 tons per acre annually, or

2¼ tons of pulp worth £7 to £8 per ton f.o.b.; and an area of eight square miles would suffice to keep a mill making 10,000 tons per annum supplied *in perpetuum*.

Besides bamboo, there are several species of annual grasses suitable, of which the *bhabar* or *sabai* (*Ischæmum augustifolium*) of Central India may be taken as a representative. These are capable of being treated by the alkaline method, which involves considerably less capital outlay than the acid process, and may be worked profitably on a much smaller scale. The pulp produced is equal to that of Esparto and suitable for high-class printing and writing papers, and is worth about £9 to £10 per ton f.o.b.

Of course there are other factors necessary to success, such as manufacturing facilities, percentage yield of fibre, and other technical and scientific details which need not be dealt with in an article intended to indicate the broad lines, only, of a possible new industry. I shall be glad to enter into these points with any correspondents desirous of fuller information. Enough has perhaps been said to call the attention of State authorities and land-owners to the opportunity now offering itself to make profitable use of the fibrous plants now rotting away or being burnt in annual fires on their waste lands and forests.

BAMBOO.

Amongst the fibrous products of our tropical and sub-tropical forests, none is more likely to take a more leading place as a paper-making material than bamboo. Its accessibility, being generally found within reach of waterways down which it may be rafted; the size of the stems, giving a larger return per head per day for the cutting and collecting force employed than in the case of the smaller annual grasses; the ease with which it yields to the same methods of treatment which have been so successful with wood, together with its great abundance, mark it out as the fittest and most natural successor to the position occupied by the spruce and pine trees during the last thirty years; while its power of self-reproduction makes it impossible that the process of exhaustion of

supply, which has taken place in the case of these timbers, can ever happen with bamboo.

Its use in modern paper-making is by no means a new idea. Thirty-five years ago, an English paper-maker (the late Thos. Routledge) proved its suitability, and but for the advent of wood-pulp, it would probably have been adopted then as a leading staple. The nearness of the Scandinavian forests and the apparently inexhaustible supply of both wood and water-power, drove it into a background from which it may now emerge by reason of that same inexhaustibility having proved only apparent. This period of seclusion has not been without its compensations. Thirty-five years ago, the acid process, which has been so important a factor in the development of woodpulp, was only simmering in the brains of its inventors, and there was room for doubt as to whether the alkaline method, then in vogue, would prove cheap enough for bamboo. Woodpulp had to pass through a long period of experimental struggle before its manufacturing processes reached anything like economic perfection. No such time of difficulty and doubt need be anticipated for bamboo. Wood has done the pioneering for it; the acid process stands unchallenged for good results and economy, and its application to bamboo presents no more difficulty than its transfer from spruce to pine. It is in fact an easier material to treat than either of these, for its porosity, due to its system of capillary sap tubes, assists the entrance of the liquor employed to break down the ligneous tissue, in a manner not possessed by any of the woods hitherto employed.

Besides its porous character, bamboo presents other features in which it has distinct advantages over wood. The preliminary preparation of the latter is an expensive and unsatisfactory process. The bark has to be carefully removed. All the hard deeply sunk resinous knots, so common a feature in coniferæ, have to be carefully bored out, and all old scars and wounds with their accretions of resin and dead tissue must be carefully excised. In spite of the greatest care, some of these defects are bound to escape attention, to afterwards appear in the finished product as disfiguring chips of undigested and unbleachable material. Bamboo has neither bark

nor resinous knots, and the only part requiring elimination is the nodes, which are so clearly defined as to present no difficulty. The reason for separating them is that, being harder and denser than the internodes, they require severe chemical treatment, and are therefore best dealt with separately.

The percentage of pure fibre (cellulose) contained in any raw material is of course of great importance in estimating its value. Few of the possible sources of paper-making fibre contain more than half their raw dry weight, many contain only a third or less. In this respect, bamboo occupies a very satisfactory position. My own long series of laboratory analyses approximate very closely to an average of 51 per cent of cellulose for the internodes, and 45 per cent for the nodes, and in actual practice on a commercial scale I have found an all-round yield of 45 per cent to be quite reliable.

With all fibre-yielding plants, there is a distinct stage of growth at which the fibre is at its best both in quantity and quality. In the case of the annual grasses and best fibre plants, this stage is just previous to, or during flowering, and before the formation of seed, after which rapid lignification sets in involving deterioration of the fibre. Bamboo, however, from its peculiar habit of flowering only at periods of thirty to fifty years, does not permit of this simple indication being utilised, since except at these rare periods, all the stems we see mature, wither and die without flowering. It is therefore important to fix the age at which it will give the best results. In order to determine this, I have carried out a series of observations and experiments extending over nine years. The net result of these goes to show that bamboo is at its best for fibre soon after coming through its second monsoon (the monsoon in which the young stem first appeared being reckoned as the first), when it is from sixteen to twenty-two months old; at this age it has fully developed its branches and thrown off the hard, hairy, siliceous sheaths which protect the early development of these; and it has commenced with its own root system a life independent of the parent stem. It is at the age in which it is passing out of a sappy, riotous,

overgrown youth, into a staid hardened middle age. Previous to this, sap, gums and waxes are in excess, and the fibre still immature in strength and toughness. If permitted to pass through a third monsoon, there comes an increase in the deposition of silica within the tissues, with a corresponding decrease in the percentage of fibre and a greater difficulty in isolating it, owing to the hardening of the ligneous tissue in which it is embedded.

In the May number of the *Tropical Agriculturist* I indicated five tons of dry bamboo per annum as a fair average crop per acre. This is for stems of the age mentioned in the preceding paragraph, and has been arrived at by observations extending over several years on selected plots of poor to fair growth only. I purposely rejected figures obtained from plots of luxurious growth in order to err abundantly on the safe side. It is therefore a very conservative estimate. The Burma Forest Department put the general average for such stems at seven tons per acre, and they put the available bamboo jungle within reach of waterways in that province, at approximately 60,000 square miles. On these figures, and estimating a yield of 45 per cent of cellulose, Burma alone is capable of producing a hundred and twenty million tons of pulp per annum. The potentiality for the whole of South Eastern Asia runs into figures so enormous as to be beyond our grasp. My own estimate for Burma is five tons per acre on 20,000 square miles, giving an annual possible output of 28,000,000 tons. I am quite prepared to admit that this is too conservative, but even so, it is sufficient to establish the fact that the industry can never suffer from a lack of supplies as is now the case with woodpulp, of which the present annual demand is under 8,000,000 tons, and which may be expected to increase to 15,000,000 in twenty years.

The cost of raw wood sufficient to make a ton of pulp has now advanced to from £3 to £4. For bamboo, the same item amounts to £1. There is in this fact alone a *primâ facie* case for bamboo, and carefully framed estimates indicate that a bamboo pulp worth £8 10*s*. in England, and £9 10*s*. in Japan, could be made here and delivered in either country for from £7 to £7 10*s*. per ton. On the capital required, these figures represent annual net earnings,

after providing for depreciation, of 40 per cent, and in the present state of woodpulp supplies, there is every likelihood of the values quoted rising.

FIBROUS ANNUALS.

Although bamboo is likely to take the leading position among new sources of paper-making material, it by no means exhausts the possibilities of our tropical and sub-tropical forests, which teem with fibre-yielding plants of every order and variety. The difficulty is not to find them, but to make a selection of those likely to prove profitable in use. It is not necessary here to enter into details of methods used, and principles underlying the process of elimination of the unfit. Suffice it to say that out of the many hundreds of fibre-yielding species, only those of the order *Gramineæ*, apart from certain woods, are suitable for modern paper-making, and of these comparatively few fulfil all the necessary requirements. It is desirable to be explicit on this point, in order to avoid the disappointment which is certain to result from attempts to exploit plants, merely because they have been proved to contain fibre.

It is, above all things, essential that the plant is in sufficient abundance, in any given locality, and sufficiently gregarious in habit, to bring the cost of collection down to a minimum. The importance of this will be fully realised, when it is remembered that all costs incurred in handling the raw material must be multiplied by 2½ or 3, in order to arrive at the cost on the finished product, since the yield of cellulose will rarely exceed 40 per cent and may be as low as 30 per cent of the dry weight of the plant. Then, the quantity available, at or near the proposed factory site, must be sufficient to produce a paying output. This is an item which will vary considerably in accordance with other manufacturing facilities available, but as a minimum I would be inclined to insist on an annual crop of 7,500 tons, dry weight, within economic range of the factory. In the case of bamboo, the amount should be at least 10,000 tons. The question of what constitutes a profitable yield of cellulose also largely depends upon local conditions. Where the manufacturing and export facilities

are exceptionally favourable, a raw material giving 30 per cent may prove a paying proposition. Under other circumstances 40 per cent may be necessary. Generally speaking, nothing under 30 per cent is worth considering.

Most of the fibrous annuals can be successfully treated by the alkaline method of reduction, and in this respect they have an advantage over more highly lignified materials like bamboo, which require acid treatment. The capital cost of buildings and machinery is considerably less, and need not be on so large a scale in order to get on to a paying basis. On the other hand, the working cost per ton of pulp is greater, but this again is compensated for by the product being of a better quality and worth a higher price.

It is impossible to deal at length with all the fibrous grasses known, but as types of the classes most worthy of attention we may refer to three species which have already proved of value for paper-making.

Munj (*Saccharum sara*)—a reed-like grass found on *chur* and waste lands in Northern India. Very gregarious in habit, growing in dense thicket-like masses, which can be cut and collected at low cost. Being generally found in the neighbourhood of rivers, the economic radius of collection is widened by the possibilities of water transport. Yields an excellent, easily bleached pulp, similar to that of wheat straw.

Bhabar or Sabai (*Ischæmum augustifolium*)—a grass of the bent or rye-grass type, growing extensively on the Central Indian tableland, in tussocks, and fairly gregarious. Produces a pulp similar to that of Esparto. Is the leading staple of the Calcutta paper mills. Economic radius of collection limited by the hilly nature of its habitat, and the cost of cart and rail transport. In certain localities this could largely be eliminated by pulp mills erected in the centres of producing districts.

Eta (*Beesha travancorica*)—a reed allied to bamboo—common on the Tinnevelly and Travancore hills. Although found only at high elevations (3,000 ft. and over), it is so densely gregarious and luxuriant in growth, that its low cost of cutting and collection compensates for transport charges out of the hills, and in several

localities water carriage is available. One of the most promising sources of paper-making material.

Wild grasses, similar to those in nature and habit, are to be found scattered all over South-Eastern Asia. Provided that they contain at least 30 per cent of cellulose, their value as paper-making material depends entirely on the manufacturing facilities associated with their locality of growth. The proper surveying, testing and valuation of these scarcely falls within the scope of the non-expert observer, but certain broad principles may be laid down for his guidance, which will at least prevent him going to any expense over propositions which the expert would at once condemn as hopeless. *These will be briefly indicated in the concluding part of this article.*

Before leaving this branch of the subject, a word may be said about rice straw. Usually the cultivated straws are worth more for other purposes, and it may be accepted as an axiom that the paper-maker can only use that which has no value for any other purpose. Rice straw has a considerable paper-making value, and in districts where it is grown in quantities largely in excess of local requirements for fodder and other uses, and where suitable manufacturing facilities exist, there are good grounds for enquiry into the possibilities of a straw-pulp industry. It yields a pulp of high quality, and for which there is a good demand. Textile wastes lie outside the scope of these articles, but I may be excused for referring to one of them, in order to announce a development which may be of considerable interest to the cotton grower, and especially to the decorticator and presser of the seeds. The fine down adhering to the decorticated husks, though of high value as a paper material, has hitherto been impossible to work, owing to the difficulty of separating it from the husks. This difficulty has now been overcome. By a simple and inexpensive process, the down can be isolated and made use of for the highest grades of paper.

The ordinary waste of cotton factories and gins has too much dirt, foreign matter and particles of husks associated with it to be of much value for pulp-making; but where a local demand exists for brown, grey and casing papers, it may be profitably transformed into these. Spinning mills are themselves considerable users of

casing and packing papers, and groups of these would find it advantageous to have a paper mill in their midst to use up their waste and supply them with the product therefrom.

FACTORS OTHER THAN CELLULOSE.

The modern division of paper-making into (1) pulp manufacture, and (2) paper manufacture proper, has greatly extended the area from which it is possible to draw supplies of raw material, by eliminating freight cost on the waste. Whereas formerly the paper-maker had to import from 2 to 3 tons of material to produce a ton of paper, he now imports the pure cellulose from the pulp-maker, from which he can produce 90 to 95 per cent of paper. As a matter of trade convenience the division suits both parties. The pulp-maker's principal interest is to be near his sources of raw material, and the paper-maker's to be close to his market, since he has to meet a demand which is continually varying in its requirements of quality, colour, size, weight and finish.

The search for new sources of paper-making material can therefore be conducted solely from the view point of the pulp-maker, and it may be useful to the non-expert observer if we conclude this series by indicating the chief considerations other than an abundant supply of raw material necessary to the successful conduct of a pulp-making enterprise. Unless these exist in association with, or within economic reach of the material, the most promising supply of the latter may be comparatively useless. If they do exist in more or less abundance, a *primâ facie* case may be established for submission to expert examination to ascertain their exact value, and the compensatory effect which the excellence or abundance of any one or more of them may have upon the deficiency or inferiority of others.

We will assume that a perennial supply of raw material, yielding a paying percentage of useful cellulose is in sight. The most important of the other necessary factors are as follows :—

(*a*) Site for mill—its position with respect to export of the manufactured goods, and the facilities for bringing the raw material to it, in cases where it must be at

some distance from its supplies. Cases may occur where it may be important to decide whether the mill had better be situated close to the raw material, or near a port of export. The ideal, of course, is for material, mill site, and port to exist together.

(*b*) Labour—especially the forest labour required for cutting, collection and transport of material.

(*c*) Source of power—either steam or water-power. In the case of the latter electrical transmission from a distance may be feasible.

(*d*) Fuel for manufacturing purposes—waste timber will usually be available, but where the driving power must be steam, it may be necessary to have a supply of coal.

(*e*) Water for manufacturing purposes—a plentiful supply, clean and bright, or capable of being made so by simple settling and filtering arrangements.

(*f*) A supply of lime within economical reach—with these in sight plus raw material, a fair case can be made out for full and exacting enquiry into the possibilities of a pulp-making industry.

Judging from some enquiries received, it seems necessary to specify exactly what is meant by "pulp" in this connection. I have, for instance, been asked if the waste "pulp" produced in separating aloe fibre from the leaf is of use. The more technical term of "half-stuff," that is, half-made paper, describes it more precisely. It consists of the nearly pure fibre or cellulose of the plant, separated and isolated from the lignose and pectose constituents by chemical and mechanical means, made into thick sheets and dried. Though sometimes bleached by the European and American paper-makers, it will be preferable to export it from the tropics in the unbleached condition, and the bleaching, if necessary, done by the paper-maker.

As we have been dealing with *new* fibres for paper, we have not considered it necessary hitherto to make any reference to new sources of *old* fibres. In south-Eastern Asia these may be said,

speaking broadly, not to exist; but an exception must be made in favour of the higher ranges of the Himalayan region containing varieties of spruce and pine similar in composition to those now being used in Europe and America as pulp-woods. When we consider the splendid floatway and water-powers afforded by the Himalayan rivers, the possibility of pulp-making there does not appear to be remote; but apart from this, suitable soft-wooded non-resinous timbers are, in the tropics and sub-tropics, conspicuous by their absence in sufficient abundance to warrant attention.

Mr. Gladstone's phrase, "the consumption of paper is the measure of a people's culture," has passed into a commonplace, and although doubts may be held as to what extent the consumption of the yellow press, the penny dreadful and the sixpenny awful, is represented by culture, yet in the main it may be accepted as a pregnant and suggestive truth, and especially so in the case of a people just emerging from ignorance into knowledge. The struggle to reach a higher plane may be protracted and apparently doubtful, the gropings in the dim of the dawn wearisome and disappointing, but the bound into fuller light is apt to come with the suddenness of sunrise. It is this which makes any prophecy as to the future requirements of the chief medium in the distribution of culture somewhat like guesswork. In the United Kingdom the average consumption per head of population is something like 50 lbs. per annum. In Bosnia it is 1 lb., in India one-tenth of a pound. At any moment a sudden advance of such communities in the scale of culture may create a situation parallel to that between 1890 and 1907, when the world's consumption increased from under three million tons to eight millions per annum. But if we leave such spurts out of account, and base estimates on the steady and normal growth only of the past few years, we shall open out a prospect quite sufficiently encouraging to the pioneers of new sources of supply; and in putting the present deficiency at 250,000 tons per annum, and estimating a gradual growth in the demand, *in excess of what present sources can supply*, amounting ten years hence to one and a half million tons, we shall be on perfectly safe ground.—(*Tropical Agriculturist.*)

ORIGINAL ARTICLES.

FOREST DIVISIONS IN BURMA AND THE UNITED PROVINCES.

In an article written by me in the *Indian Forester* for March 1906, under the heading of "Proportion of Staff to Revenue in Burma," the Garhwal Division in the United Provinces and the Minbu Division in Upper Burma were contrasted. I was transferred from one province to the other in 1904 and could not help being struck by the very different conditions prevailing in the two divisions.

After all, Minbu, like all Divisions in Upper Burma, is of comparatively recent origin, dating back as it does only to the annexation of 1885. Divisions in Lower Burma are of much older date, and so it may be of interest to put together a few remarks as to the impression, one of the oldest of all—Tharrawaddy—has made on an officer, whose first twelve years were spent in North India.

2. Prior to 1906 the Tharrawaddy Division corresponded with the District of the same name, and the area of the forests included in it was about three times that of the Garhwal Forests. In 1906 the Division was split up into two; the old name being retained by the southern half, and the northern half being known as the Zigon Division. Both the Divisions are now about the same size as Divisions in the United Provinces.

The Garhwal Division lies partly inside the hills and partly outside. The plains outside are about 1,000 feet above sea-level and the hills rise to about 4,000 feet.

It is very much the same in Tharrawddy, except that the plains are only about 100 feet above sea-level and the hills of the Pegu Yomahs only rise to about 2,500 feet.

Departmental working of teak in Tharrawaddy.

3. None of the present generation of Forest Officers whose services have been spent wholly in the United Provinces know, from experience, what the departmental extraction of timber

on a large scale is like. In Tharrawaddy they would find their hands full of it.

In Prome, Zigon and Tharrawaddy, (a group of the three oldest divisions in Burma), the extraction of teak is done by departmental agency, and it is no secret that there is no immediate intention of leasing these forests to purchasers.

The inspection of girdlings and of fellings is a matter which should have had far more attention than it has actually received. The latter part of this article will give one very good reason why more has not been done, *viz.*, the want of any facilities at all in the shape of good roads by which officers can move about rapidly all over the forests. Further, this timber work is only one of the multifarious duties of the Divisional Officers. Had these divisions been leased to private firms, there would have been an European Manager with three or four European assistants in each of them. The firm working the forests being the department itself, the business has simply been put on to the shoulders of the Divisional Officers themselves, with one or two assistants apiece. In Pyinmana, for about the same annual outturn by private agency, fifteen European officers are employed by the three firms working the forests.

The profits are large, and would be still larger if more attention could be given to the operations. Losses through logs getting burnt in the forests or buried in the rivers, or stolen in transit, never appear in accounts; neither do losses through defective logging of trees. For one case that is reported, there are probably a dozen that are never heard of. The contractors, too, who do the work are most of them small men, working with borrowed capital.

Roads and Buildings in Garhwal.

4. Road-making was taken in hand seriously in Garhwal fully fifty years ago, and has been continued ever since. There is now a system of more than 400 miles of cartroads and bridle-paths in the hills; all made and maintained by the department. The network of cartroads is now so complete, that it is possible to remove timber by cart from within a mile or so of the least accessible compartments.

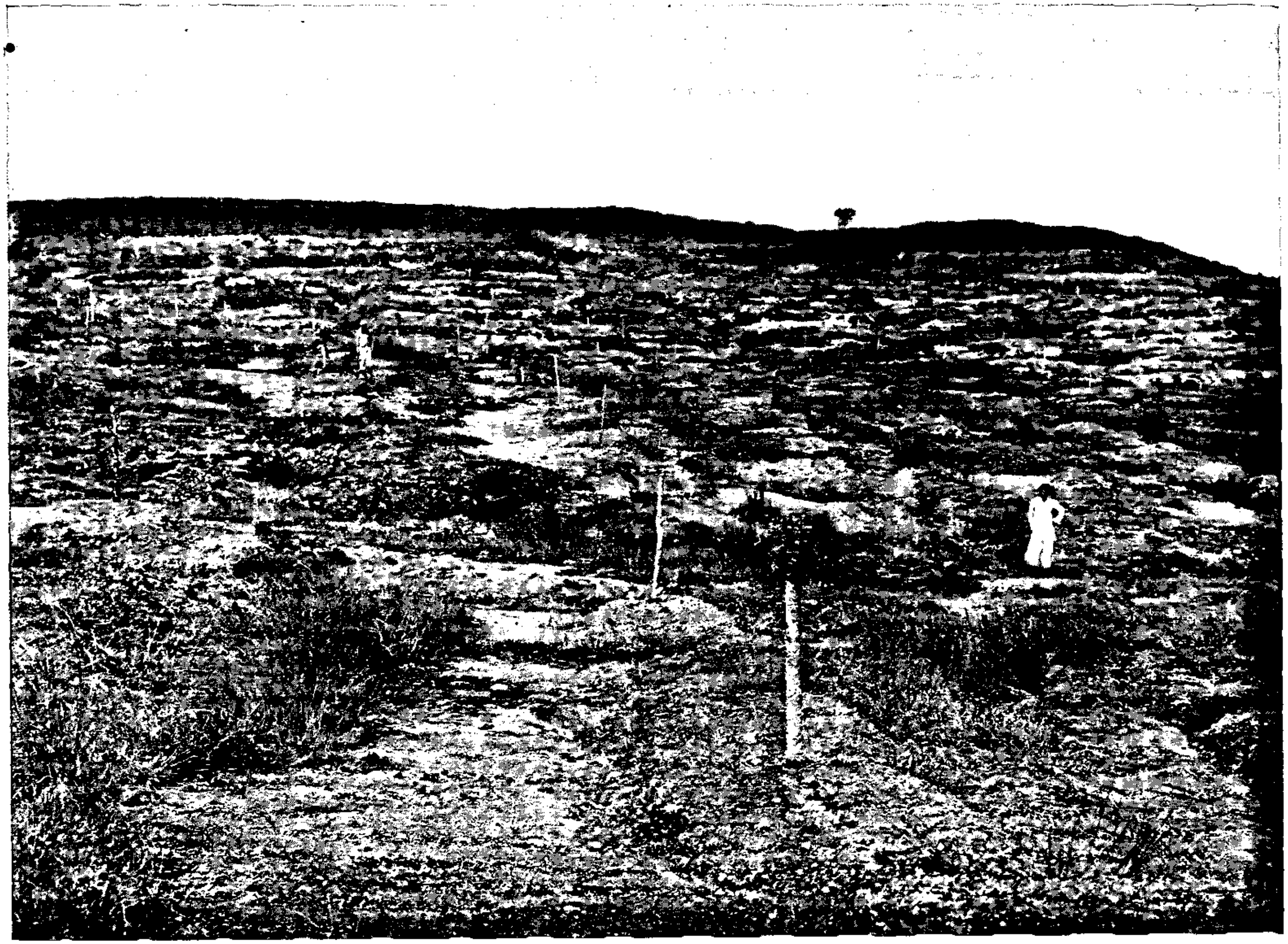


Photo-Mechl. Dept., Thomason College Roorkee. Photo. by S. Shalom & Bros.

AFFORESTATION OF SEMINARY HILL, NAGPUR, C. P.

There are some twenty-four rest houses in the division. The buildings are of stone or brick. None have less than two rooms; most of them have more. Only on occasions when more than two officers meet together are tents required, unless it is for the pleasure of a change or a shoot.

The style of architecture varies. There are no hard-and-fast standard plans. A Divisional Officer who is keen on buildings can generally please himself as to the design. Most houses are single-storied. The walls are generally 18 inches thick, plastered and whitewashed inside and pointed outside; the best floors are of brick-on-edge in lime mortar and covered with cement. The roof is of tiles, slate, or iron sheeting, according to circumstances. Occasionally terraced roofs are made, but they are troublesome. Thatch used to be general, but it is now condemned* owing to the risk of fire. Windows and doors are glazed. One detail in design, which is never forgotten, is not to allow the sun to shine more than can be helped on the walls of the chief rooms. Hence the broad verandahs which are so general. They also serve another very useful purpose in reducing the glare.

Camping in Garhwal.

5. For the carriage of kit camels are generally used in divisions like Garhwal. At the beginning of the field season each officer can hire as many as he likes at Rs. 8 or Rs. 9 a month. He keeps them for the whole season. During halts they come in very useful for bringing in firewood and, at times, elephant fodder. Two good camels can carry as much as one elephant. Twelve to fourteen animals is the usual number for a senior officer, three or four paid for by Government for office kit and tents, the rest private.

Transport being cheap and plentiful, there is no necessity for imposing rigid limits to the amount of kit taken into camp. You can take anything you like from a box of tools to an *Encylopædia Brittanica* if you wish to. On a winter's evening in an armchair by the fire you can be as comfortable as at home. During the heat of the day in the hot weather by keeping the doors shut you

* Under recent orders the use of thatch for forest resthouses is now allowed.—HON. ED.

can keep the temperature from 10 to 15 degrees lower than it is outside. Punkahs are also generally available.

It goes without saying that marching about in camp is under the easiest possible conditions. In the cold weather, camels usually travel by day, as breakfast out of doors is common. In the hot weather it is better to send most of the camels on ahead by night. On nine occasions out of ten, no matter how early you wish to get to the next camp, you may depend on finding everything in its place on your arrival. If there is nothing to stop for in the way, a move from one camp to another is nothing more than a pleasant ride of an hour or two before breakfast. You have all your energy available for a full day's work at the other end.

Elephants in Garhwal.

6. Lastly, but perhaps most important of all, every Divisional Forest Officer and most assistants are given the free use of an elephant apiece, not for baggage but for riding. Instead of having to inspect fellings, or anything else, on foot, a Divisional Officer can do it on the back of an elephant. The hills that cannot be negotiated in this way have to be very steep indeed.

Elephants for riding are especially useful in plains forests with heavy grass and shrub-growth. I know nothing more tiring than to have to tramp on foot through heavy grass, 3 to 4 feet high. Blundering over hidden stumps and fallen timber and dodging wet low-hanging branches, you have to pay as much attention to your feet as to the outlook overhead. From 7 to 10 o'clock in the morning at this sort of thing takes it out of most men and leaves them with very little desire to do anything else for the rest of the day. The work done, too, is very small. In a single morning, on the back of an elephant a man can inspect as much forest as it would take him three or four mornings to see as thoroughly on foot.

Roads in Tharrawaddy.

7. Having sketched such a pleasing picture for Garhwal—and the same remarks hold equally good for the whole province,—can I do the same for Tharrawaddy? It is a matter of regret that this is impossible.

A bigger contrast it would be hard to imagine. First and foremost road-making has never been seriously taken in hand and pushed on.

EXPENDITURE ON ROADS IN 5-YEAR PERIODS.

Period.	Garhwal.	Tharrawaddy.
	Rs.	Rs.
1883-84 to 87-88	71,401	717
1888-89 to 92-93	70,139	528
1893-94 to 97-98	74,027	7,338
1898-99 to 1902-03	44,337	5,400
1903-04 to 07-08	47,371	9,214
Total for 25 years ...	3,07,275	23,197

The figures for Tharrawaddy refer to the old division now comprising both Tharrawaddy and Zigon.

A good way of representing the contrast afforded by these figures is to state that in Garhwal Rs. 25 a year has been spent per square mile of reserved forests during the past twenty-five years, whereas in Tharrawaddy only one rupee two annas has been devoted to this purpose.

8. With one solitary exception, during the past twenty-five years, nothing whatever has been done beyond a little repairing of village paths and cart-tracks.

With all due respect to my predecessors and past Conservators, I cannot help but think that the policy adopted was not a good one. Whatever that policy was nominally, in effect it came to this, that as teak—the only valuable timber in the forests—will float, roads are not wanted for its extraction, and any sort of footpath or cattle-track is good enough for inspection purposes.

Once inside the hills I only know of one single march, (and that only the 5 miles from Seywa to Panhla Te), for which carts can be used. Elephants have to be used for all the rest.

9. Without fear of contradiction it may be stated that not one man in a thousand can lay out a good alignment for a cartroad or path, for any considerable length in hilly country, without a level of some kind or other. Many years ago this was recognized in India. In the United Provinces no Forest Officer would dream of laying out a road in the hills without one.

With the one solitary exception already referred to, I find it hard work to believe that a level has ever been used in Tharrawaddy. The result is deplorably bad, and it is safe to say that half the little money actually spent was money thrown away. Anyone who has tried his hand at improving an old village path without a level knows how heart-breaking a business it is.

The Tharrawaddy bridle paths are hopeless, pretty well all of them. Really good roads can never be made along them. They must be abandond altogether. Gradients vary from anything up to 45°. Now and then you may get a fairly level stretch on which it is possible to canter, but, more often than not, you have hard work not to slip over your pony's tail or head in trying to ride up or down some impossible incline. I am not much of a rider myself and prefer to walk rather than to emulate the feats of the Italian cavalryman.

It is also to be remembered that it is more or less waste of money to build a road without attending to repairs from year to year afterwards. The heavier the rainfall, the greater the damage done annually to roads in the monsoon. Some ten years ago the hill path from Yetho to Kywemakaing in Tharrawaddy was improved by re-alignment and widening in places. Since then little or nothing has been spent on the road, with the result that it has reverted to its original condition,—so narrow in places that two persons cannot walk abreast.

Good alignments necessarily mean extra expense in the making of roads. If a tree or bamboo clump comes in the way it is cheaper to skirt round it, but the saving is an expensive one.

On the other hand, a good deal of the extra cost of making good roads is recovered in subsequent repairs. Erosion during the rains on easy gradients is far less than on steep ones.

10. The exception to which reference has been made is noteworthy. *About 1903, whilst Mr. Troup was Divisional Forest* Officer and Mr. Slade was Conservator, the opening up of the forest for the extraction of species other than teak (chiefly Pyinkado) was seriously considered. As a start it was decided to make a road about 12 miles long in one particular locality. A section, two miles long, was made on a really good alignment. Levelling instruments were used. Mr. Troup then went away (five years ago) and . . . . and . . . . not a pice more has been spent since. The project was voted too elaborate and expensive. Why? Because the amount of mature Pyinkado within easy reach of the proposed road did not appear likely to be enough to pay for the cost of construction. A more short-sighted policy it would be hard to come across. A road once properly made will remain a road for all time with a reasonable amount on repairs. Even if the immediate return in revenue is not likely to be great, future returns on an increased scale may be counted upon. The list of species other than teak that are saleable to-day is longer than it was twenty years ago, and will be still more so twenty years hence. Whether they are saleable or not in many given forests will depend solely on accessibility.

It is safe to say that if the men who built the roads in the Garhwal forests had only made such as would yield an immediate return in increased revenue, then they would not have made one in fifty, and yet to-day I doubt if there is a single forest officer acquainted with the forests who thinks there is a single road too many or that a single rupee too much has been spent on them.

11. The bearing of road work on inspection is a matter of importance. A pony is of very little use at all in the Tharrawaddy hills. You have to walk most of the way, either direct from camp to camp or in any other direction to visit any particular bit of forest. This is all very well for a forest guard on Rs. 12 a month,

but it is not an economical way of making use of the services of an officer on Rs. 1,200.

Transport of baggage is by elephant. Divisional forest officers in Burma are usually allowed two, for which Rs. 2 a day is deducted from their travelling allowance. On level roads baggage elephants can cover 3 miles or more an hour. On the Tharrawaddy type of track $1\frac{1}{2}$ miles is a good average.

12. The drainage basin of the Thonze river includes 100 square miles of valuable teak forest that has been exploited under a working-plan for the last twenty-five years. To this day there is only a village footpath up the main valley. Last year in March I did a march of 6 miles up the river, starting from the place where it leaves the hills. I left camp at 6 A.M. and got to my journey's end at 10-30, dead tired, after everlasting scrambling over spurs, blundering over boulders and wading through pools. My elephants left at the same time as I did, but did not turn up until 1 o'clock. Then my unfortunate servants had to put the camp straight and give me breakfast. Once bitten, twice shy, ever since then, when on the march inside the hills, I have taken the precaution of having a coolie with a tiffin basket handy. When 10 o'clock comes round, I stop and have breakfast wherever I am. The Burmans' ideas of distance are very crude and exasperating. "Not far off" may be anything up to 2 or 3 miles, and "quite close" may still lead you a dance of a mile or more.

Incidentally I cannot help but remark that feeding at irregular intervals does not pay for man any more than for any other animal. Irregular meals may be put down as one of the contributing causes for the excessive wastage amongst forest officers. We all make light of it in our early days, later on most of us have to pay for so doing.

Buildings in Tharrawaddy.

13. In the *Indian Forester* for October 1906, I was severely taken to task for some photographs of mine in the June number, which I then stated and still maintain were typical of the style of accommodation, other than tents, that forest officers at that time had to put up with in Minbu.

EXPENDITURE ON BUILDINGS IN 5-YEAR PERIODS.

Period.	Garhwal.	Tharrawaddy.	Remarks.
	Rs.	Rs.	
1883-84 to 87-88 ...	15,598	10,720	* Tharrawaddy figures include some Rs. 35,000 spent on houses and offices at head-quarters.
1888-89 to 92-93 ...	24,581	7,971	
1893-94 to 97-98 ...	21,235	14,804	
1898-99 to 1902-03 ...	28,626	18,953	
1903-04 to 07-08 ...	34,380	45,280	
Total for 25 years ...	1,24,420	97,728 *	

For the money spent, Garhwal has now to show several sets of quarters for range and beat officers and some twenty-two substantial rest-houses of stone or brick, worth, say, an average of Rs. 2,000 each, only very small expenditure on head-quarters houses or offices is included in the above figures. Deducting Rs. 35,000 for expenditure at head-quarters, the Tharrawaddy expenditure in the forests is reduced to about Rs. 60,000 and, for this money, there are now some four or five substantial timber rest-houses worth about Rs. 1,500 each and about twenty-five wood and mat houses of a very temporary character worth, say, Rs. 500 each, with a life of not more than twenty years and comparatively heavy expenditure on upkeep. Quarters for subordinates are included, as there is very little to choose between them and the old rest-houses.

In twenty-five years Tharrawaddy has spent only about half the Garhwal amount on buildings in the forests. In connection with this, it should be remembered that coolie labour in Northern India costs 4 annas a day at the outside, whereas in Tharrawaddy a coolie can never be got for less than 8 annas a day. A rupee on labour in Burma would go twice as far in the United Provinces to put the two divisions on an equality, the Tharrawaddy expenditure on forest buildings ought to have been double that in Garhwal instead of being only half.

14. *The older type of forest rest-house in Burma, and still* the commonest type met with, consists of a timber framework, plank floor raised some 10 feet from the ground, bamboo mat walls, and thatched roof. There are usually two bed-rooms with bath-rooms, and verandahs back and front. The thatch is not put on as in India and anything up to a foot thick, but consists of a thin layer that does not always keep out the direct rays of the sun, let alone rain. Strands of coarse grass are bent double and threaded on thin bamboo sticks, 5 to 6 feet long. These sticks are tied in rows on to bamboo rafters. In most of the houses I have been in there are about four rows of sticks to the foot, *i.e.*, they are 3 inches apart. I have seen them 6 inches apart. It can be imagined how thin the roof is and what a poor protection it is from the sun.

Whilst in Minbu I had a curious experience, although common enough in Burma. At the beginning of my first rains I happened to go to a place called Myebintha. It began to rain ; first, one box had to be moved to get out of the way of a leak and then another. In the end the whole of my camp kit was stowed away under my bed and on top at night, I spread a tarpaulin with an umbrella over my head. This was in a forest rest-house Fortunately a few days of fine weather followed and I promptly pulled off the old thatch, sent for some new thatch and made the men put it on with the layers of sticks as close together as they could possbily be fixed (12 to the foot). I then had a roof that was effective against both sun and rain. The Burmans were all certain that it would be a failure ; the thatch would rot, rats would infest the roof, and what not. Fifteen months afterwards (*i.e.*, after its second rains), the roof was as good as ever, and I have no doubt that it stood for another two years before being completely re-built.

15. The mat-walling may be double ; it is not infrequently single. With a view to economy or to increase ventilation (I don't yet know which), the walling is not generally carried up into the sloping part of the roof. Sometimes there is a passage between the two bed-rooms, sometimes there is not. A pin dropping in one room is heard in the next. Woe betide you if you happen

to be in camp with any body who snores! It shakes the whole house. Ventilation being so plentiful, both through the walls and, over them, to say nothing of the floor and roof, such luxuries as glazed windows would be useless and are unknown.

15. It is a pleasure to be able to record that in recent years the erection of a better type of house has been taken in hand. On my arrival in Tharrawaddy I found three good rest-houses, built of more substantial timber with plank walls and good roofs. One roof is of Mangalore tiles, the other two are of asbestos slate. The introduction of tiles into Burma is of comparatively recent origin. They cost no more than teak shingles to put up and subsequently require less money on repairs, besides having a far longer life.

A stage in the erection of forest buildings has been reached in Burma, when a definite change of procedure is indicated.

In early days, when pioneering work was in progress, when divisions were in a state of fusion and operations were spread irregularly all over the forests, houses of a temporary type were right enough. Now things are very different. Divisional charges are definite, and, if many are too large, the lines of sub-division are known and are being given effect to by degrees. Working-plans too, are steadily, if slowly, spreading themselves over the country. All these developments mean that operations will be permanently in progress and inspection will be permanently required year after year in the same localities, unless and until, in fact, the forests in Burma cease to have any value to the State.

This being granted, the question naturally arises whether many of our buildings ought not to be of as permanent a type, as say, those built by the Public Works Department. Localities where houses exist, or are required, can be put into one or other of three groups :—

(*a*) Buildings only temporarily required.

(*b*) Permanent buildings required, but out of the question at present owing to want of skilled labour or to inaccessibility.

(*c*) Permanent buildings required and possible to construct.

The lack of roads is one reason why so many localities in Burma at present fall into class (*b*). This is bound to change, and with greater rapidity year by year. In the meantime there is plenty to do in the erection of good buildings at places that are already in class (*c*).

In classifying localities I do not wish it to be supposed that I would put places into (*c*) simply because they happen to be easy to get at. As good accommodation is not required at a place only visited for a day or two in the season as at one which is almost constantly in use.

16. The state of things in Tharrawaddy may be quoted as a very good illustration. There already exist some 30 square miles of teak plantations irregularly dispersed, but, with the included forest, falling into four groups covering a total area of 100 square miles. For the next fifty years at least, thinnings and other cultural operations at regularly recurring intervals will be required in the plantations. In the intervening natural forest opportunity will also be taken to carry out improvement fellings as required. However much the policy of the Forest Department may change in other respects, if one thing is certain, it is that for the next half century, one or more forest officers will continue to spend a good deal of each season in one or other of the eight or nine houses adjacent to the plantations.

Some six of these camping grounds are outside or only just inside the hills, and are even now accessible for cart traffic. To sum up, it is possible to land good materials at moderate cost at these half-dozen places; it is possible to induce good carpenters (Chinamen) to go to them, and the houses would be so much used that there is every justification for going to the expense of erecting first-class houses at them.

17. An important detail to be mentioned is that of cost. Forest building work is done too much on the cheap. I plead guilty as much as anybody. The money we divisional officers get to spend is never as much as we want, and so we are constantly trying to make two impossible ends meet. Two second-rate houses are of more use to us than one first-class one.

In class (*c*) localities, forest buildings ought to be of as permanent a type as those put by the Public Works Department. It is waste of money to use good materials without good workmanship. The three good houses that Tharrawaddy possesses are built of teak, and yet the carpentry is so poor, that they will cost a lot on repairs, if they are to last as long as well-built houses. It is absurd to suppose that the Forest Department can build a house (or make a road) without paying for the work at much the same rates as the Public Works Department. The three houses already referred to cost from Rs. 1,500 to Rs. 2,000 each. Excluding royalty on the timber used, the Public Works Department would probably have charged Rs. 3,000.

So long as funds are limited to their present dimensions, and the present policy remains unchanged, divisional forest officers will continue the present state of things. It is not for me to dictate to the Government. Nevertheless I may be allowed respectfully to invite attention to the urgency of the demand for more money and a different policy in the use of it. Given the funds and with practical details worked out, no insuperable difficulties in the way of building good houses and roads should present themselves. The divisional forest officer's troubles would largely disappear. At present the building of a house is a source of worry from start to finish. Contractors are such small men and have so small a margin of profit, that it is the exception, rather than the rule, for them to carry out all that they undertake to do. A man takes up a contract, gets an advance and then throws up the work half done; then another man has to be found, and possibly a third. With good rates, and a carefully thought-out plan of operations for the erection of one or two houses a year for the next ten years, substantial men could probably be found, ready to take up contracts for two or three adjacent divisions and spread over several seasons.

I do not advocate the handing of these building works over to the Public Works Department. The average forest officer is capable of building good houses if called upon to do so, and as they are primarily intended for his use, he is in the best

position to know what is wanted. The cost of supervision is also saved.

It is for consideration, however, whether the amount of constructive work, under the policy indicated and with plenty of funds, would not justify the engagement for a term of years of special engineers under the control of the Forest Department. This would be one step in the direction of setting forest officers free to give their whole time to the duties for which they are specially trained. Tharrawaddy and Zigon together could very well do with such an engineer now.

Wells.

18. I may be scoffed at for seriously stating that irregular meals are worth bothering about, but no one will be inclined to question the value of good water, both for drinking and for the cooking of food. The plains forests of Oudh can boast of an excellent system of masonry wells. It is a standing order in the Oudh divisions that the sinking of no well is to be stopped without special orders until it has a head of 15 feet of water. In the driest of seasons it is always possible to draw up a bucketful of water without stirring up the mud at the bottom. The wells are plastered inside and out, so that the risk of pollution by surface drainage is reduced to a minimum. The wells are periodically cleaned out, and at least once a year at the beginning of the camping season a sack of charcoal is thrown in.

In Burma the state of things is very different. Too often the only water available at the rest-houses is from streams that are reduced to a trickle in the hot weather; and this, too, close to villages with their swarms of cattle. Outside the hills there are plenty of village wells in Tharrawaddy, but only the part above ground is plastered, and the bricks are set without mortar. In the hot weather it is common to find only a few inches of water. Bath water of the colour of pea soup is put up with as a matter of course in many places.

19. The extent to which the foregoing figures, with regard to roads and buildings in Tharrawaddy and Garhwal, are true for the provinces as a whole, may be gauged from the following tables :—

EXPENDITURE ON COMMUNICATIONS AND BUILDINGS IN 5-YEAR PERIOD.

(i)—Roads and Bridges (A VII a).

Period.	United Provinces.	Burma.
	Rs.	Rs.
1883-84 to 1887-88...	2,50,407	4,194
1888-89 to 1892-93...	2,92,503	3,576
1893-94 to 1897-98...	2,80,267	30,599
1898-99 to 1902-03...	2,36,517	44,404
1903-04 to 1907-08...	2,96,475	3,02,115
Total for 25 years ...	13,56,169	3,84,888

(ii)—Buildings (A VII b).

1883-84 to 1887-88	1,71,632	47,349
1888-89 to 1892-93	2,05,615	54,092
1893-94 to 1897-98	2,48,449	2,75,688
1898-99 to 1902-03	2,50,689	2,84,370
1903-04 to 1907-08	4,59,468	4,65,127
Total for 25 years ...	13,35,853	11,26,626

(ii)—Other Works (A VII c).

1883-84 to 1887-88...	19,299	19,281
1888-89 to 1892-93...	19,277	13,466
1893-94 to 1897-98...	34,473	24,480
1898-99 to 1902-03...	34,187	37,854
1903-04 to 1907-08...	49,830	57,381
Total for 25 years ...	1,57,066	1,52,462

(iii)—Total (A VII).

Period.	United Provinces.	Burma.
	Rs.	Rs.
1883-84 to 1887-88...	4,41,338	70,824
1888-89 to 1892-93...	5,17,395	71,134
1893-94 to 1897-98...	5,63,189	3,30,767
1898-99 to 1902-03...	5,21,393	3,66,628
1903-04 to 1907-08...	8,05,773	8,24,623
Total for 25 years ...	28,49,088	16,63,976

The area of reserved forests in Burma is about five times and of unclassed forests about ten times that in the United Provinces. In total, the Forest Department in Burma has a hand in the management of about eight times the area of forests under its control in the United Provinces.

It is satisfactory to note that in the last 5-year period expenditure in Burma rose to the level of that in the United Provinces. Nevertheless, this satisfaction is tempered by the knowledge that the area of forests is some eight times as large and that labour is twice as expensive. In reality the outlay in the five years ending with 1907-08 on communications and buildings per square mile in Burma was to that in the United Provinces as an anna is to a rupee.

Fire lines.

20. Without touching on the much-debated subject of the results of fire-protection in Burma, a few remarks may be made as to the method of protection.

Although the protection from fire of small areas of forest (generally for the sake of plantations in them) dates back in divisions like Tharrawaddy as far back as such protective measures in Northern India, yet the extension of the operations to forests as a whole is of much more recent origin in Burma than in India. It is therefore only to be expected that Burma had, and may still have, a lot to learn from India in this respect. In spite of this I

take it that the majority of the forest officers in Burma (and specially the younger men) do not know much about the evolution of fire-protective measures in India. Details have never been published. This is all the more to be regretted as it is one contributing cause of the waste of a good deal of time and money. When I joined the service in the United Provinces in 1891 the retention of trees on fire lines had long been condemned ;—all lines were clear cut. Nevertheless it was not until 1906 that the same decision was embodied in standing orders in Burma. In those same standing orders themselves it is a matter for regret that technical terms were not given the same meaning as in India. What is universally known as a fire line in India is *officially* termed a fire trace in Burma.

21. The *Indian Forester* for December 1908 contains a summary of the proceedings of a conference of Forest Officers in the United Provinces, held at Naini Tal on 19th September 1908, to discuss the methods of fire-protection in operation in view of very unsuccessful results in recent years. The subject is one which concerns all provinces equally. Conditions are not so dissimilar in any of them that the experience gained in one province can have no value for officers engaged in similar operations in any other.

The Naini Tal conference came to the conclusion, that it is unsafe to dogmatise as to the best method of protecting forest from fire. Fifty feet clear cut lines may be sufficient in one locality ; and yet 100 or 200 feet may be ineffective in another. However, this may be, there can be no two opinions that, having decided to clear a line in a particular locality, no pains should be spared in laying it out.

To most effectively serve its purpose a fire line in flat forest should be absolutely straight, and in hill forest as much so as is compatible with easy gradients. The conference already alluded to, laid a great stress on the rapid communication to range or other head-quarters of news of a fire and on the rapid concentration at the fire itself of all the available coolies. To accomplish the latter purpose a fire line must have a good road either in or near it.

In the plains forests of Oudh fire lines are absolutely straight for miles. In hill forests such as Garhwal, they usually follow natural features such as ridges or watercourses. If a fire line must go up a steep incline, then care is always taken to align a path zig-zag up it, so that the slope can be ridden up or down with safety.

22. I sincerely wish I could say something good for the Tharrawaddy fire lines, but it is not to be done. They are everything that a fire line should not be. There is not a redeeming feature about them. What can you say for fire lines in flat forest which corkscrew about in all directions following the vagaries of village cart tracts? What can you say for fire lines which, in hill forest, cut straight across country?

The object of fire-protective measures is two-fold; firstly to keep fire out of a forest, and secondly to put out quickly any that do occur. The first calls for clean lines; and clean lines are not to be got without plenty of patrolling by responsible officers.

The inspection of 10 miles of hill fire line in Garhwal would in most cases mean only a ride before breakfast. In Tharrawaddy it would generally mean starting at daylight and not getting home till dusk, and without the use of a pony. No wonder that the majority of the fires which occur do so by crossing outer fire lines. It is not a fair test of the efficiency of lines simply to compare results in divisions that are not under the same conditions. The Tharrawaddy hill forests are so wet, that they will only burn for about four months a year. The Minbu forests are so dry, that they must be protected fully six months of the year.

23. *The fault lies in* a too ready acceptance of pre-existing lines and in assuming that nothing particular is to be aimed at in chosing the lines themselves. On one occasion, when I suggested extra expenditure on re-aligning a certain line, I was pulled up short by being told that fire lines are not intended to be permanent and may change from time to time; this was about an interior line too.

I may be wrong, but, in my opinion, if it is intended to protect a forest at all, no money is too much to spend on the choosing of

fire lines so that they may be absolutely the best that it is possible to have in the given locality. If it takes five years to make them, then do so, and get them *all* ready *before* attempting to protect the forest at all. The amount really chargeable to fire-protection on such lines need not be so large after all. Many lines are only required because of traffic through the forests. Such lines serve both purposes, and whatever is spent on making them into good cart or bridle roads should be debited to A-VII.

This brings me back almost to my starting point. Just as it is hopeless to get good roads by tinkering at village paths and cattle tracks, so it is hopeless to try and turn these same tracks into good fire lines. The only plan that will bear the test of time is to study the locality until you can make up your mind as to the ideally best system of roads and lines, and then, ever keeping this in view, only to depart from it at definite points and for definite and sufficient reasons. With this on record in an accessible form, the men who come after you can appreciate your difficulties and profit by your experience.

Staff and Labour Supply.

24. The camping season in Garhwal extends over 7½ months of the year. The divisional forest officer leaves Naini Tal, the head-quarters of the division, towards the end of October and takes the whole office with him to Ramnagar, a native town at the foot of the hills, and actually inside the division. Naini Tal itself being some 25 miles away outside.

At Ramnagar in the first week of November is a great gathering of hillmen to whom contracts for repairing roads, clearing fire lines, etc., are given. In November and December a swarm of men come down from their hill villages for work in the foot-hills during the winter. The ordinary rate is Re. 0-2-6 to Re. 0-3-0 a day. As a rule, the same men take up the same contracts year by year.

It is fortunate for the Forest Department that these hillpeople do come down. They go back again in March and after they have left, very little labour is to be got at all. During May and the earlier half of June, if the divisional forest officer wishes to do so, he can spend most of his time at cool bungalows on the tops

of the hills, with nearly the whole division spread out like a map all round him. If a fire occurs in the forests far away, he can generally locate it and be on his way to it long before any direct messenger could reach him.

25. About 15th June the rains set in and the divisional forest officer returns to Naini Tal. Half the forest establishment goes on leave for two months in July and August and the other half in September and October. During the rains the forests are practically shut up. There is not much that it would be worth while to float out, and the hill rivers in flood effectively block all road traffic. Natives, too, will not willingly enter the forests in the lower hills during the rains on account of the risk of fever.

In writing the above I forget that conditions change. My remarks were true five years ago. Since then a branch line of railway has been run to Ramnagar and may have altered things considerably.

In September the divisional forest officer holds an auction at which the right to fell and remove trees marked in selection and improvement fellings is put up for sale in lots. Contracts are usually only for one season. Whatever is left behind reverts wholly to the Government. This sale is attended by all the chief timber traders in big towns, such as Lucknow, Cawnpore, Meerut, Delhi, and Agra.

Having taken up lots, contractors send up in November and December from Delhi and other places hundreds of sawyers who live in the forests until March, when they return to their homes. By them trees are sawn up on the spot. The scantlings are carried by coolies to the nearest cartroad. This is rarely very far, as temporary cart tracks are run into the coupes.

After the big plainsmen have taken all they want from a coupe there is generally a lot of inferior yet saleable stuff left, such as tops and branches, hollow trees, etc. Hillmen take up contracts for extracting this refuse, doing most of their work with the axe. All this takes time, and the felling operations in a coupe are usually spread over three or four seasons. In the first year the big contractors, in the second year the small men, and in the third and

fourth year the departmental felling or girdling of trees that purchasers will not look at.

26. In Tharrawaddy conditions are very different. The working season is short, labour is expensive and the supply of it is insufficient, and extraction by private agency is in the hands of a multitude of small men over whom control is difficult.

The working season begins on 1st December and ends soon after the middle of May, some 5½ months only. In December and January every man in the district who likes can earn from Re. 0-8-0 to Re. 0-12-0 a day in harvesting paddy. In the best half of the season, therefore, progress with forest operations, such as thinnings, improvement fellings, girdling, etc., is handicapped for want of labour. The average Burman too, in Tharrawaddy, does not take kindly to road work. He doesn't mind hacking down bamboo clumps and grubbing up trees, but he does not like earthwork. The little I have been able to accomplish in the past two seasons would not have been done without Indian coolies. Here again conditions are very disheartening. Last year a gang of about twenty coolies started work for me in December. By the middle of March, owing, I believe, to the wretched water-supply, nearly all of them were so soaked with malaria, that the whole gang cleared off.

27. In referring to any particular part of the year as the working season in Burma, I am not quite correct. Forest operations and camping are far more general during the rains in Burma than in Northern India. In the submontane divisions in the United Provinces no camping whatever is done in the rains. Divisional forest officers rarely leave head-quarters except for short visits to outside depôts.

In Burma a lot of forest work is done in the wet season weeding and cleaning of plantations, girdling, etc., and it is the custom for officers to tour about in the forests on and off all the year.

It is hard for a new-comer to see the necessity for this, and it is only too lamentably obvious that men suffer in health from the exposure to which they subject themselves.

Here, again, I must run the risk of repetition. If men must camp in the forests in the rains by so much the more, is it worth while to give them a respectable road under foot and a decent roof overhead?

28. As to the necessity now-a-days for so much camping in the rains, I hardly dare to express myself on paper. For instance, I was jumped on in 1906 for suggesting that weeding of plantations was overdone in Minbu and appeared to be so elsewhere.

If wholesale work on daily labour is done in the rains, it must be inspected and at short notice, otherwise bills will amount up enormously. With contract work it is not so essential. For example, cleaning of plantations is a big item in Tharrawaddy. This is a purely mechanical operation of cutting back bamboos. In the dry season 1908-09 I made a point of getting together rough estimates of the probable cost of the cleanings in each of the compartments to be operated upon in 1909-10. With these figures as a guide I have given out contracts this rains. I have not been out to see the results. December and January will be time enough for that. On the range officers' reports I pay half now. If on inspection in January I am satisfied, the contractors then get the balance.

As a matter of business, I do not care if I pay at the start more than on daily labour. Competition is bound to lower the figures later on. Local people, too, have a far greater interest in taking up the work. If they make a good *bonâ-fide* profit, let them. It is cheaper and better for them to do so than to attempt to check the stream of peculation by dishonest subordinates through fictitious muster-rolls. In nine cases out of ten, contract work is cheaper than on daily labour. For example fire-protection in Minbu in 1905-06 on daily labour cost about Rs. 60 a square mile.

In the following year I gave out everything I possibly could on contract and the average cost was about Rs. 30 a mile.

Incidentally it may be remarked that one range officer cooked his muster-rolls wholesale in 1905-06. He took care to abscond before a warrant for his arrest could be obtained.

Photo-Mechl, Dept., Thomason College Roorkee. Photo. by S. Shalom & Bros.

AFFORESTATION OF SEMINARY HILL, NAGPUR, C. P.

Concluding Remarks.

29. Without any desire whatever to run down Burma, it has been impossible to put the case more mildly and yet to invite attention to possible lines of improvement. If I was not keen on my profession I would not have taken up my pen to write this article, for fear of the misconstruction that might possibly be placed on it.

I am not aiming at men—my brother officers—but at things. A forest officer said to me only a year ago, "if men who go from one province to another do not point out differences, how can the men who have served only in one province hope to benefit by outside experience," and by *benefit* he meant either to be confirmed in a belief in one's own methods or to realize that improvement is either possible or practicable.

This article cannot well be concluded without referring to the main cause of the present backward state of affairs, *viz.*, the inadequacy of the staff. Everybody knows this, but we have grown so accustomed to the idea that we pass it by. A properly-run division seems an impossible dream in our time. Nevertheless this article is penned with the hope that it may help a little towards better things, besides being of interest to foresters in general.

THARRAWADDY: F. A. LEETE.
8th November 1909.

AFFORESTATION OF SEMINARY HILL, NAGPUR, CENTRAL PROVINCES.

I.—Introduction.

The work was started on September 1st, 1908, and will continue for three years from the above date. The sanctioned estimate for the three years is Rs. 25,000, out of which Rs. 15,100 have been spent up to date. A plane-table survey of the whole area was made to facilitate the record of works carried out.

II.—Object of Management.

(*i*) To make Nagpur cooler by reducing the refraction and radiation of heat from the bare sides of the hill.

(*ii*) To improve the appearance of the civil station.

(*iii*) To improve the grass. This has been entrusted to the Agricultural Department, and for this purpose plots totalling 50 acres have been demarcated by them and will be ploughed and sown with selected grasses.

III.—Description of Tract.

(*i*) Configuration of the ground.—The area treated this year consists of 100 acres of level ground on the top of Seminary Hill and another 50 acres along the slopes. The area forms part of a continuous ridge from Tiger's Gap to Telenkheri, a distance of about 3 miles. The highest point of the plateau is about 75' above the deepest valley and the slopes on the whole are fairly gentle.

(*ii*) Underlying rocks and soil.—The formation of the hill belongs to the Deccan Trap. These rocks on disintegration yield a red ferruginous clayey loam, fairly fertile where deep. On the plateau the subsoil consists of partially disintegrated trap, locally known as moorum, covered with a 9" layer of soil filled with boulders. In my opinion the soil is too superficial and porous to support young seedling growth, and unless regularly watered during the hot months, for two years, the plantation will fail. The slopes are washed bare of soil which, however, collects in ravines and hollows lower down. Such places, where silt has accumulated to a certain depth, are conspicuous on account of the good growth they support.

(*iii*) Climate.—The climate is remarkable on account of its dryness and the great variations of temperature at different seasons of the year. The prevailing wind is from the south-west, which during the summer months, March 15th to June 15th, becomes very dry, hot and violent, and this combining with the shallowness and extreme poverty of the soil renders seedling growth, in all but well tended plantations, impossible. The monsoon rains nominally commence by the first week in June and continue till the end of September. The average annual rainfall is 50". The climate is, on the whole, healthy even during the severe dry heat of summer.

(*iv*) Growing stock (advance growth).—There are two small plantations on the hill, one belonging to the Roman Catholic priests, and the other is situated in the Parsee Cemetery. These trees have been growing at an average rate of 2 to 2½ feet a year and show what we might expect from our plantation if carefully tended. The remaining scrub-growth near the seminary is the result of an attempt at afforestation made by Sir B. Fuller about ten years ago. The species (which have survived) are Teak, *Terminalia tomentosa*, *Boswellia serrata*, *Acacia Catechu*, *Acacia leucophlœa*, *Acacia arabica* and *Zizyphus Jujuba*. This plantation was neither fire-protected nor closed to grazing, and the growth under such adverse circumstances is indeed good. The hardy Acacias, particularly Khair, on the east edge of the hill have stood the test admirably and have put on an average height growth of 9" a year. The method employed by Sir B. Fuller was sowing in rows in ploughed lines.

WORKS CARRIED OUT.

I.—Roads and Buildings.

(*i*) Roads.—The roads have been constructed with a total length of 20 chains at a cost of Rs. 56.

(*ii*) Buildings.—A single-room *naka* costing Rs. 451 and a three-room *naka* Rs. 1,243 have been constructed for the staff.

(*iii*) Wire Fencing.—About 3½ miles of wire-fencing has been erected along the boundaries of the area at a cost of Rs. 6,085.

(*iv*) Gates.—Seven gates have been constructed for Rs. 600.

II.—Arboriculture.

(*i*) Nurseries.—Three nurseries were started in May to test the germination of seed prior to sowing, and also to yield a supply of plants for filling up blanks over the area. One was taken in hand by the Agricultural Department for which no bill has yet been received. The remaining two were made by the Forest Department at a cost of Rs. 25.

(*ii*) Roadside Planting.—The plants along the roads were put out in pits :—

(*a*) 5′ diameter and 5′ deep and at intervals of 40′.

(*b*) 3′ × 3′ × 4′ and 20′ apart.

(*c*) 1′ × 1′ × 1′ and 10′ apart.

The moorum being very coarse and of poor quality, it was considered necessary to refill the pits with a mixture of equal quantities of black cotton soil and moorum. These pits were then manured and planted with the following species:—*Poinciana regia* (Gold Mohur), *Ficus religiosa* (Pipal), *Dalbergia Sissoo* (Sissoo), *Eugenia jambolana* (Jamun), *Pongamia glabra* (Karanj) and *Albizzia odoratissima* (Chichwa). With the exception of *Dalbergia Sissoo*, which has suffered rather badly from the attacks of defoliating caterpillars, all the species put out are doing very well. The cost of roadside planting was as follows:—

	Rs.
181 plants put out in pits 5′ diameter and 5′ deep along main P. W. Department roads	... 464
127 plants put out in pits 3′ × 3′ × 4′ along minor roads	... 182
159 ,, ,, 1′ × 1′ × 1′ ,, ,,	... 18
Total	... 664

(*iii*) Plantations.—Plantation (*a*) 1·1 acre 321 pits, 1′ × 1′ + 1′ in lines 10′ apart and 10′ between lines, were made and refilled as for road-side planting. The following species obtained from Seminary Hill nursery were planted here:—Gold Mohur, Sissoo, Karanj, Chichwa, Khair and Panjra (*Erythrina suberosa*). The cost was Rs. 27.

Plantation (*b*), 5 acres.—Twenty-six pits, 3′ × 3′ × 4′, were made in lines 66′ apart and 66′ between lines. These pits were refilled as above and planted with mango, Sissoo, Karanj, Chichwa, Bahera (*Terminalia belerica*), Arjun, Mohwa and Nim. The cost amounted to Rs. 36.

Plantation (*c*), 6 acres.—One hundred and thirteen pits, 4′ × 4′ × 1′, in lines 10′ apart and 10′ between lines, were made and planted up with the following seedlings: Chichwa, *Diospyros Melanoxylon* (Tendu), Karanj, *Melia indica* (Nim), *Bassia latifolia* (Mohwa) and Panjra. The cost amounted to Rs. 33.

Plantation (*d*), 5 acres.—Thirty-three pits, 2′ × 2′ × 2′, were made where the soil was good and 13 pits, 3′ × 3′ × 4′, were made in hard moorum. The pits were refilled as before, manured and planted with the following species :—*Ficus religiosa*, *Ficus bengalensis*, *Ficus infectoria*, *Eugenia jambolana*, *Schleichera trijuga*, *Anogeissus latifolia*, *Lagerstrœmia parviflora*, *Albizzia procera*, *Soymida febrifuga*, *Terminalia belerica*, *Ixora parviflora*, *Tectona grandis*, *Cassia fistula*, *Butea frondosa* and *Phyllanthus emblica*, at a cost of Rs. 18.

Plantation (*e*).—Twenty-five pits, 4′ diameter and 4′ deep, were made in groups round the *nakas* and planted with mango seedlings, at a cost of Rs. 37.

Plantations (*f*) and (*g*), 5 acres each.—Combined sowing and planting was carried out in these plots ; 371 pits, 4′ × 4′ × 1′, were made and refilled with equal quantities of moorum and black cotton soil. Every other line was planted and the intermediate lines were sown as below :—

Species planted.	Species sown.
Albizzia odoratissima (Chichwa) ...	Bassia latifolia (Mohwa).
Pongamia glabra (Karanj)	Ougeinia dalbergioides (Tiwas).
Cassia fistula (Amaltas)	Gmelina arborea (Sewan).
Terminalia belerica (Bahera).	

The cost amounted to Rs. 75.

III.—*Afforestation of Slopes.*

(*i*) Bunds (weir).—These were constructed in all the ravines over the area, their object being to check the velocity of the flow of water down the slopes and to deprive it of its eroding action.

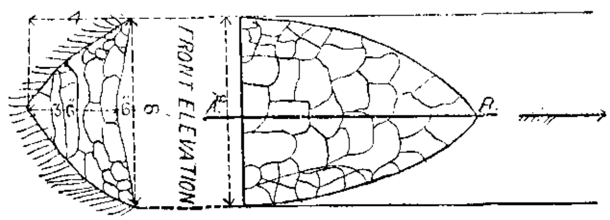
They also serve as pockets to retain the silt washed down from above. The greater majority of them were built of boulders obtained *in situ;* where boulders could not be obtained within a reasonable distance, they were constructed of blocks of moorum and waste bricks. The bunds were constructed after two patterns as shown in the accompanying sketches, *viz* :—

I

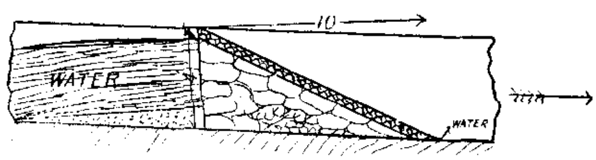
I.—Having the waste weir at the sides, and

II.—Having the waste weir in the centre of the bund.

II.—Plan.



Longitudinal Section on A.B.



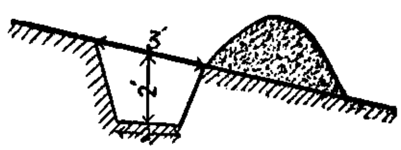
Accumulation of silt.

N.B.—The sketches represent an average bund.

I.—The moorum banks of the ravines, which in the dry season with great difficulty yielded to the pick and crowbar were considered well suited to stand the flow of water over the waste weir, but the first heavy rain showed that this was a mistake. The top layer of moorum weathering after each shower was carried away, thus causing increasing gaps at the waste weir. This naturally weakened the bunds and several of them gave way, while others which had already silted up were being gradually emptied. These were repaired and the defect remedied by making them

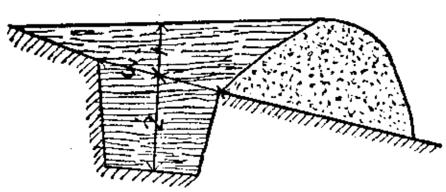
after pattern II. The cost of an average bund is Rs. 1-8-0 and the total expenditure up to date on bunds has been Rs. 428-8-0. Such bunds as had accumulated a fair amount of silt were planted up with bamboos, Pipal, Gold Mohur, Chichwa and Nim ; these young plants are doing well.

(*ii*) Catch-water drains—Were constructed along contour lines (on the slopes), the three top rows consisted of interrupted trenches varying in lengths from 50 to 100 feet with a cross-section as shown in the sketch, the excavated soil being placed as a continuous spoil bank along the down hill edge. The intervals between the rows were 12 to 15 feet. The object desired was that these trenches would check the rush of water down the slopes and would refill themselves with silt washed down from the flat ground above. The spoil banks consisting of a very coarse quality of moorum were sown with hardy species, *viz* :—



Cross Section of Catch-water Drain and Spoil Bank.

Zizyphus Jujuba (Ber), *Acacia Catechu* (Khair), *Acacia leucophlœa* (Hewar) and *Nyctanthes arbor-tristis* (Kharasni). Trenches, 6 to 10 feet long, were made over the remainder of the slopes, in rows 12 to 15 feet apart, and these as far as was possible were filled with soil, scraped from round about the trenches and the level raised above the ground with a gentle slope away from the spoil bank ; a glance at the figure will explain every thing clearly. This gives an average depth of 3 feet of soil in the centre of the trench. These mounds were manured with one or two small baskets full of manure (*gamela*) and sown with three species of seed in parallel rows about 12" apart. The most exacting species, such as Mohwa, Chichwa and Nim were sown in the middle and



Cross Section of Catch-water Drain and Spoil Bank after Refilling.

the other less exacting species on both sides. The species sown on these mounds are as follows:—

Scientific name.	Vernacular name.	Per cent. of germination.
Bassia latifolia	Mohwa	75
Zizyphus Jujuba	Ber	60
Albizzia odoratissima	Chichwa	75
Melia indica	Nim	60
Acacia leucophlœa	Hewar	75
Acacia Catechu	Khair	75
Cochlospermun Gossypium	Gongal	10
Nyctanthes arbor-tristis	Kharasni... ...	30
Ixora parviflora	Lokhandi ...	20
Dodonæa viscosa	Kharata	20
Boswellia serrata	Salai	75
Buchanania latifolia	Char	50
Sterculia urens	Karai	*Nil.*
Anogeissus latifolia	Dhaora	*Nil.*

The growth on the slopes, particularly in places where it had a good start, is very promising indeed. Salai cuttings, 6′ to 8′ long and 2 to 3 inches diameter, were scattered over the northern slope worked this year. Nearly 40 per cent. have already come into leaf. The cost of operations on the slopes amounted to Rs. 2,300.

IV.—Afforestation of Level Ground.

(*i*) Ploughing and Backering.—The area treated was ploughed in lines 3′ wide and 5′ apart after which it was backered. The cost under this head amounted to Rs. 1,000.

(*ii*) Hoeing.—The above operations left the ground very uneven and full of boulders, offering a very poor seed-bed. In order to improve the seed-bed the ground was subjected to hoeing,

which consisted in levelling and clearing the lines of boulders and other objectional matter. The cost amounted to Rs. 235.

(*iii*) Sowing.—Sowing was started on the 15th June, each species was confined to a separate line, and the seeds were sown in patches, 3′ square and 5′ apart. From 8 to 10 seers of seed were sown per acre. The following are the species sown on the level ground :—

Scientific name.	Vernacular name.	Per cent. of germination.
Albizzia odoratissima	Chichwa	75
Pongamia glabra	Karanj	80
Acacia arabica	Babul	60
Diospyros Melanoxylon	Tendu	75
Melia indica	Nim	60
Buchanania latifolia	Char	50
Tectona grandis	Sagoan	Just germinating.
Ougeinia dalbergioides	Tiwas	75
Schleichera trijuga	Kusam	*Nil.*
Anogeissus latifolia	Dhaora	*Nil.*
Terminalia belerica	Bahera	80
Bassia latifolia	Mohwa	75
Soymida febrifuga	Rohan	30
Dalbergia Sissoo	Sissoo	60
Pterocarpus Marsupium	Bijasal	*Nil.*

The slopes were sown a fortnight after the level ground, but the young growth is much more vigorous here than above. The superior growth is no doubt due largely to the manure mixed with soil. An area of 8 square chains on the plateau was planted with Salai cuttings, 1 inch diameter and from 6 to 15 feet high. Over 75 per cent of these cuttings are now in leaf and they make a fine show on the bare ground. It is to be hoped that these cuttings will

be put out on a larger scale next year. Large branches of *Ficus bengalensis* take as readily as the Salai and grow much quicker. Another advantage of the *Ficus* over the Salai is that it is an ever-green tree (the Salai sheds its leaves during the hottest month of the year). The *Ficus*, however, requires good soil and will have to be planted in pits filled with a certain amount of black cotton soil. The cost of sowing amounted to Rs. 50 or annas 8 per acre, and the cost of levelling lines with tin labels, Rs. 114. The total cost of afforesting the level ground was Rs. 1,410-8-0.

(*iv*) Weeding.—Seventy-five acres of the ploughed area have been weeded at a cost of Rs. 75 or Re. 1 per acre.

V.—Injuries.

White-ants are attacking Babul and Gold Mohur seedlings and a great deal of damage has been done to other seedlings, many of which have been completely defoliated by caterpillars and grass-hoppers. The Gold Mohur is a fast-growing and ornamental tree, but healthy plants, five and six years old, have been killed by whiteants in Nagpur, and for the above reason it should not be introduced into the plantation to any extent.

VI.—Establishment.

The writer who joined this division from Dehra Dun on April 14th has been in charge of the work since that date. The other members of the establishment are a forester, two forest guards, a mali and two watchers. This large establishment is absolutely necessary since the whole area has to be patrolled at night as well as by day. Establishment charges amounted to Rs. 705.

E. HORE,
Forest Ranger, Nagpur.

12th September 1909.

[Mr. Townshend, I.F.S., Nagpur, has kindly forwarded four photographs (Plates 1 to 4) to give an idea of the area after the first year's work. He states that he will be very grateful for advice regarding this afforestation work, and requests that readers who have practical experience of similar schemes will kindly help by sending us the results for publication.—HON. ED.]

Photo-Mechl, Dept., Thomason College Roorkee. Photo. by S. Shalom & Bros.

AFFORESTATION OF SEMINARY HILL, NAGPUR, C. P.

SHIKAR, TRAVEL, AND NATURAL HISTORY NOTES.

ATTEMPTED RECAPTURE OF AN ELEPHANT.

SIR,—I think the enclosed account may prove sufficiently interesting to be given a place in your Shikar columns. Our tame elephants are turned out at night to graze and occasionally one of them rejoins a herd of wild elephants. It is almost a point of honour for the mahout to recover his elephant, and the enclosed shows how persevering and plucky the men are.

17th December 1909. F. LODGE.

I have to report the death of elephant "Bhagavathi" which has occurred under the following circumstances:—

On 28th October 1909 the elephant Jemadar reported to the Range Officer, Nilambur, that "Bhagavathi" could not be found at feeding time the previous evening. She had been hobbled and turned out to graze in the 1891 plantation of Edacode. The Range Officer ordered the Jemadar and mahout to go in search at once, which they did, taking a Forester and 15 coolies. On the 29th as "Bhagavathi" was not caught, though her tracks were found, the Range Officer went and joined in the search.

On the 30th the two search parties were out, but did not find "Bhagavathi."

On the 31st three search parties searched Vellachipaly forests in different directions. In the evening the Jemadar met the Range Officer and reported that his party had found "Bhagavathi" in a herd of wild elephants, but that all attempts to separate her from the herd had failed. The Range Officer immediately arranged for the three search parties to combine, and on the morning of the 1st November the combined parties, consisting of some 30 men followed the tracks until they reached the neighbourhood of Amarampalam Kalam, where, owing to the fact of several herds having passed over the same ground the previous day, it was impossible to be certain of the line "Bhagavathi" had taken.

On the 2nd the search was continued by a party under the Jemadar and Forester and the Range Officer returned to Nilambur to get some experienced trackers if possible.

On the 3rd the Range Officer with fresh trackers returned to the Edacode forests where he was informed in the evening by the Jemadar's party that a large herd of elephants were near Panthikadavu, east of Vellachipaly.

On the 4th the whole party including 33 coolies followed up the herd which divided into two, each half going in a different direction. The herd in which "Bhagavathi" was found to be was followed till 7-30 P.M., and then the party had to halt at Pathikadavu.

On the 5th the Range Officer had fever, but the search was continued by the rest of the party. On coming up with the herd, the men tried to separate "Bhagavathi," but a wild tusker charged them and they had to fall back.

On the 6th the Range Officer had to return to Nilambur and send out provisions for feeding the party. In the evening the party halted at a place called "Graman" in Amarampalam Range. On the 7th the party came up with the large herd and two mahouts went up close to investigate when a tusker, who was lagging behind charged them from behind and injured them both before they had got out of his reach up trees. They were sent to Nilambur hospital.

On the 8th the party came up with the herd again, and the same tusker charged, but a Pamien called "Billie" and Forest Guard Charu and one Isoof of Mambat met his charge with bullets from three borrowed rifles and he was driven off. The herd went off some distance after this, but was followed and on coming up with it a muckna charged but was badly wounded and driven off. The herd appears to have split up after this, and at 6 P.M., "Bhagavathi" was found in a small herd of four or five elephants. As it was late the party had to halt at Vazhikadavu for the night expecting to have little difficulty in capturing "Bhagavathi" in the morning if she remained with the small herd.

On the 9th it was found that the herd had reunited and they were followed to a hillock near Nellikutta and surrounded. A

Pamien called " Billie " very pluckily offered to go in amongst the herd and as a last resort to endeavour to wound " Bhagavathi " in the leg with his knife, or mahout's staff, so as to prevent her from making off with the rest. He accordingly went in alone with his knife, staff and an old-fashioned single-barrelled breech-loading rifle the bore of which was about ·500.

Suddenly without any warning there was a rush and about 15 elephants led by a tusker rushed towards him. On the spur of the moment he fired into the brown and one elephant fell and the rest turned off. The elephant which fell was " Bhagavathi," a most extraordinary coincidence which is only equalled by the fact of a bullet fired from an old-fashioned gun by an inexperienced mahout having killed an elephant on the spot without touching its head.

I arrived at Nilambur on the 8th and on the 9th I went and encamped at Edacara with the intention of joining in the search but arrived only in time to hear of the tragedy. On the 10th morning I went to Nellikutta and held an enquiry and saw the elephant and had it cut open. The bullet had entered the neck about 9" from the ear-hole and had penetrated the lungs, and the base of the heart, the full length of the penetration being about one yard. The hobble chain which was attached to the left leg had two links broken from the right hand chain, and to this fact which was brought about by the old and worn condition of the chain the whole affair was due.

My investigation has given me no cause to doubt the accuracy of the above story. As far as I am able to form an opinion on the subject after being in the district three days, I consider that no blame can be attached to anybody, but that on the contrary every effort was made by the Range Officer and his men to effect the recapture.

I may mention that Pamien Billie, on discovering that he had killed a Government elephant, handed the rifle to the Forester and requested that he might be shot, thinking no doubt that it would be preferable to being hung which he thought the only possible sequel to the shooting of a Government elephant.

ANIMAL COLOURATION.

The theory that the great majority of animals—both those which hunt and those which are hunted, are so coloured as to be barely visible amid their natural surroundings, is one that commands almost universal acceptance among zoologists. I was brought up on the hypothesis and gave it practically unqualified acceptance until I began to study nature firsthand instead of from books. Since that time, I have been confronted with so many birds and beasts that are not protectively coloured that I am beginning to regard protective colouration as a kind of zoological phantasy.

Biologists of the present day seem unable to refrain from riding their pet theories to death. There is more than a germ of truth in the theory of natural selection ; the hypothesis undoubtedly accounts for many of the phenomena observed in the organic world. But, to declare, as many zoologists do, that it is all-sufficient, that by it, unaided, organic evolution can be explained is puerile in the extreme. Similarly, there is a foundation of truth in the theory of protective colouration. This being so, naturalists allow themselves to be carried away by the idea, and see protective colouring in places where it does not exist. This applies to the allied hypothesis of mimicry. It is still more true of the theory of obliterative colouration which has been recently set forth by Mr. A. H. Thayer—an American artist.* That gentleman has demonstrated that an animal of which the lower parts are lighter in colour than the upper parts, as, for example, the black buck and the chinkara, is less conspicuous in its natural surroundings than it would be if it were a uniform brown all over, for the dark upper parts and the whitish lower parts tend to counteract the effects of light and shade.

This is an important discovery, since very many animals are coloured in this manner. It lends powerful aid to the theory of protective colouration. But Mr. Thayer is not content with this discovery. He founds upon it a new theory, which he

[* Vide *Indian Forester* for November 1909, p. 649, *et seq.*—HON. ED.]

carries to an absurd length. This is the theory of obliterative colouring. Mr. Thayer thinks that he has discovered two great principles which run through the whole of the animal world. The first of these, he styles the principle of the gradation of the shade of colour, "the principle of counteracted light and shade, with its corollary laws, by which almost alone the long-recognised protective colouration of animals is achieved. This gradation of the shades of colour from dark on the animal's upper *side to light on its lower is the main essential step towards* making animals inconspicuous under the descending light of the sky." According to Mr. Thayer, animals are not protectively coloured to look like clods and stumps, or like their surrounding objects; they are simply obliteratively coloured, coated as it were with invisible paints. "Whales, lions, wolves, deer, hares, mice, partridges, quails, sand-pipers, larks, sparrows, frogs, snakes, fishes, lizards, crabs, grasshoppers, slugs, caterpillars—all these animals and many thousand more crawl and crouch, and swim about their business, hunting and eluding, under cover of this strange obliterative mask, the smooth and perfect balance between shades of colour and degrees of *illumination.*"

But nature does not stop here. Mr. Thayer professes to have discovered a second mighty principle, namely, that most of the colourations, which have always been called conspicuous, are purely and potently concealing.

"Nature having visually unsubstantialised the bodies of animals, so that if seen at all, they look flat and ghostly, having converted them from solid and shaded bodies into flat cards and canvasses, completes the illusion of obliteration by painting on them pictures of the background, veritable pictures of the more or less distant landscape. Such in effect are the elaborate markings *of field and forest birds.*"

Let us now briefly examine these principles.

We may grant that the gradation of colour observed in many creatures renders them less conspicuous in their natural surroundings than they would be were they of a uniform colour. We may further grant that it is possible to almost obliterate a statue in a

diffused light by putting white paint on the surfaces in darkest shadow and dark paint on the most brightly-lighted parts, all in due proportion; that pigment can be so arranged on a solid object as exactly to nullify and obliterate the unequal distribution of light on that object. This is very far from proving that nature acts thus on animals in their normal surroundings. On the contrary, birds and beasts, far from being obliteratively coloured, are frequently very conspicuous. In the course of a walk in the country one sees without any effort hundreds of birds, beasts and insects.

Mr. Thayer answers this objection by asserting that "the artist is the only true specialist in the matter of visual appearances, *per se*—the question of how things look."

This means that the millions of men and women who are not artists do not know what the common objects of every-day life look like! We see in the compound some rich brown birds with dark head and yellow beak and legs and call them mynas, imagining that they are conspicuous objects. This is because we are not artists; if we were, we should not be able to see the myna because the bird is obliteratively coloured. When we say that wild animals look solid to us and not like flat pieces of cardboard, Mr. Thayer replies: "No, they do not, that is where you make the mistake, they look flat; it is only because you imagine that they are solid that you think they appear solid!"

Let us, for the sake of argument, grant all this. It then remains for Mr. Thayer to prove that all wild animals are artists, or, at any rate, that they do not see as we poor mortals do, but as the artist does. If he succeeds in proving this, he, then, has to explain how it is that birds of prey manage to find the wherewithal to satisfy their hunger. So much for Mr. Thayer's first principle. We have now to consider his second epoch-making discovery—that the animals which we in our ignorance believe to be conspicuous are nothing of the kind when seen in their natural surroundings. "Whence," asks Thayer, "came that old erroneous assumption that bright-coloured creatures and those with bold, sharp patterns are, of course, conspicuous in their own home?"

According to him the only way to render a tropical creature inconspicuous amid "its brilliant and minutely patchy background," is for it to be coloured " brightly and patchily in the highest degree."

"Brilliantly changeable or metallic colours," he continues, "are usually supposed to make the birds that wear them conspicuous, but nothing could be further from the truth. Iridescence is, indeed, one of the strongest factors of concealment. The quicksilver-like intershifting of many lights and colours, which the slightest motion generates on an irridescent surface, like the back of a bird or the wing of a butterfly, destroys the visibility of that back or wing as such and causes it to blend inextricably with the gleaming and scintillating labyrinthine-shadowed world of wing-swayed leaves and flowers." This is simply high-sounding nonsense. To us non-artistic mortals the beautiful little purple sunbird looks exceedingly conspicuous as it flits, butterfly-like, from flower to flower, robbing each of its hidden stores of honey. As to "veritable pictures of more or less distant landscape" being painted on the plumage of showy-looking birds, we may ask what kind of landscape is painted on the common Indian crow. This is a legitimate question, because the crow is subject to attacks by the larger raptorial birds, as, for example, Bonelli's eagle, and so seems to require obliterative colouring to the same extent as any other bird. Moreover, Mr. Thayer insists that obliterative colouring is a universal attribute of animal life. Even if a bird is difficult to distinguish when hopping about among the foliage, we are not necessarily justified in setting that bird down as an example of obliterative colouring. As Mr. Beddard has pointed out, sixpenny pieces are not protectively coloured, nevertheless it is often not easy to find one of these coins that has been dropped on the carpet. The eye fails to distinguish the sixpence amid the complicated pattern woven into the carpet.

It may be asked, why deign to take notice of so outrageous a theory? The reply is that the theory is worthy of notice because it contains a modicum of truth. Like those of protective colouration and mimicry, it is outrageous when carried to an extreme length.

Very brightly-coloured creatures are not necessarily conspicuous in their natural surroundings. Some showily-plumaged birds blend wonderfully with their environment. Not a few creatures are clothed in such a way that their colouring largely counteracts the effects of light and shade; such may be truly said to be examples of obliterative colouration. Others harmonise so well with their surroundings as to leave little doubt that they are protectively coloured. Again, others mimic such inanimate objects as twigs and leaves closely and thereby possibly deceive their foes sometimes. Any characteristic which tends to make an organism inconspicuous is probably of benefit to that organism and is likely to be perpetuated and perfected by natural selection.

On the other hand, it is necessary to bear in mind that few, if any, birds rely exclusively on protective colouration as a means of defence. When we learn more about the effect of external conditions—sunlight, heat, damp, and the like—on animal colouring, it is not improbable that we shall find that these external influences tend to cause creatures to assume the hue of their environment.

We all know how transparent jelly-fish, medusae, and other pelagic organisms are. This water-like appearance cannot be a case of protective or obliterative colouring because there are embedded in the transparent tissue of all these creatures, distinct and often highly coloured organs, which render them inconspicuous.

It is, further, interesting to notice that some creatures which assimilate most closely in colouring to their surroundings are precisely those which stand least in need of protective colouring. The sandgrouse and the houbara afford striking examples of these. They are almost invisible in their sandy habitat, but they are so swift on the wing as to be immune from the attacks of raptorial birds.

The fact that many birds are sexually dimorphic shows how little the fowls of the air need protective colouring. The white cock paradise flycatcher (*Terpsiphone paradisii*) shares equally with the more sombre chestnut-coloured hen, the duties of incubation,

and they build an open nest so that the sitting bird is well exposed to the view of all passers-by. The easiest way of finding the nest of these species is to look out for the long white streamers of the sitting cock.

In Australia a pure white goshawk flourishes alongside of the common grey species; both feed upon the same kind of prey. It is absurd to contend that each of these dissimilar birds is obliteratively coloured.

The colour of an animal depends upon a large number of factors. In many cases it appears to be correlated with strength and vitality. Thus, as Mr. Frank Finn has pointed out, gamecocks, which are artificially selected for their combativeness, are very rarely speckled; speckled plumage being in some way inimical to the fighting quality.

In numerous instances sexual selection comes into play.

The benefit derived from an inconspicuous hue is doubtless a factor in the colouring of many species, and sometimes a very important factor. These and many other forces play upon the plastic organism and the resultant of these contending forces is the appearance which the animal actually presents. To single out one of these forces, ignoring all the rest, and to try to maintain that upon this alone depends the colouring of all living creatures, is a most unscientific proceeding and one likely to bring zoology into disrepute among those who are not content to have their thinking done for them.—(*By D. D. in the Indian Field.*)

THE MAXIM REPORT SILENCER.

Barring unforeseen difficulties, the Maxim arrangement for diminishing the report of firearms seems destined to work important changes in the conditions of rifle shooting. Newspaper accounts and the publication of patents made everyone familiar in the early part of last year with the details of the device by which it was emphatically reported that the noise of firearms had been abolished. But it was essentially a case where seeing,

or, rather, hearing—better still, not hearing—is believing. Mr. Maxim's original patent was concerned with an arrangement which seemed to be hostile to the known behaviour of powder gases, an objection which certainly ceased to exist when the radically different method of the present device came to be disclosed. Briefly, the idea consists in attaching to the muzzle of the rifle a tube containing a series of stamped discs of peculiar form, whose intended purpose is to modify the outrush of gas, which ordinarily take place immediately after the bullet leaves the muzzle. A clear longitudinal space permits the free passage of the bullet past the series of chambers or compartments of which the silencer is *composed. To prevent undue obstruction of the line of sight, the* bullet passage is situated excentrically with reference to the axis of the silencer. Whether the arrangement would not better fulfil its intended purpose if it were made entirely symmetrical is a matter open to decision hereafter. The slight raising of the line of sight would be an advantage, rather than a disadvantage, if reasons existed for excusing the more cumbersome arrangement involved. The merits of this question were discussed in the article dealing with the Zeiss sporting telescope, which appeared in the *Field* of September 22nd, 1906.

The various questions concerning the effectiveness and practicability of the device under consideration, present one of the most interesting problems which has ever arisen in connection with rifle shooting, equalling perhaps in importance the conundrums brought into being by the Spitzer system of pointed bullet. At the present *stage the most essential question of all others is whether the* silencer actually does, or does not, diminish the noise produced by the discharge of firearms. The inventor, Mr. Hiram Percy Maxim, though he is the son of the well-known inventor of the same name, is working entirely independently of his father in business matters. The commercial arrangements are in the capable hands of Mr. Hart O. Berg, whose most recent title to fame is the introduction of the Wright Brothers to Europe. In rifle work, however, he is no amateur, being well known to the largest gun firms here, and especially abroad. These gentlemen have

afforded facilities for the making of certain preliminary tests of the invention, in which they are jointly interested, with a lack of restriction, which creates from the start a decidedly favourable impression. The first demonstration was given on Friday, June 11th, 1909, at an underground shooting gallery in Jermyn-street, situated in premises shortly to be opened as the King's Club. It then became apparent for the first time that a considerable rearrangement of ideas is necessary before a reliable judgment can be formed of the nature and origin of the sounds produced by the discharge of a rifle. Firing in restricted surroundings, the impact of the bullet makes a quite respectable noise of its own, which is easily mistaken for the sound of discharge. Mr. Maxim has accordingly set up a coffin-shaped trough, lined with felt in a peculiar manner, to deaden to the spectators' ears any sound that may be thrown back by the impact of the bullet into the sand beyond. In a narrow basement, surrounded by brick walls, the discharge of a full-power rifle is an experience which no one cares to repeat. With the silencer screwed on to the muzzle of the gun, the whole of the distressing aspects of rifle discharge absolutely disappeared. The experiment was carried out with various rifles, military, mid-range, and miniature and the experience was every time the same, and apparently without the slightest opening for trickery or deception. Even so, the surroundings were unusual, for the impact silencer might conceivably have had a share in the result produced. Consequently, Mr. Berg and Mr. Maxim were asked whether they would be willing to attend to the *Field* experimental shooting ground on the following Monday morning to repeat their demonstration independently of complications due to restrictions of space. The invitation having been accepted, the experiments were repeated on June 14th, with most interesting variations of the previous results, everything still confirming the claims put forward.

Shooting was first of all conducted with an ordinary ·22 Winchester rifle, firing Rheinisch cartridges. These, it will be remembered, were shown in a recent article to give a velocity of about 1,035 f.s. over twenty yards. At first there was so much noise that the silencer seemed to be producing but little effect, and

when Mr. Maxim assured us that the sound came from the impact of the bullet on the mound situated fifty yards away, the notion seemed incredible. He then asked that the direction of fire should be changed to a small hillock about 200 yards away. The extraordinary absence of sound at once confirmed the previous explanation. Other shots fired in the air gave so slight a report that they were thought to be misfires until the empty smoking cartridge cases proved that this was not so. Other shots were fired at the heap of empty cartridge shells, which is a feature of the West London Shooting School. These were sodden by a night's rain, and the bullets struck with a dull "flop," which revealed a state of practical silence at the firing point. A very curious observation was then made. Mr. Maxim's own cartridges, U. M. C. smokeless, of the kind which recently gave 899 f.s. over twenty yards, produced a sound no louder than the act of expectoration. Mr. Maxim thinks that there is a critical velocity of bullets in the region of the velocity of sound, below which, when the silencer is used, there is practically no sound, and above which there is a greater noise, the origin of which is not for the moment easy to define. The possible explanation is that the silencer is equally effective in respect to all degrees of muzzle blast, but that the bullet makes a variable amount of noise in cutting through the air, depending on the relation of its velocity to that of sound. The character of the noise produced would thus be influenced by whether the bullet keeps in front of any sound disturbances its passage may create, as distinguished from the opposite conditions where sound waves disturb the air in advance of the bullet. These points need investigation and explanation by expert mathematicians.

All questions as to the effectiveness of the silencer were set aside by passing to weapons of the military type. Meantime, in respect even to high power ·22 rifle cartridges, it was certainly observed that, though the impact of the bullet might make a sharp sound when striking the butt, mistakable by the uninstructed observer for the ordinary muzzle report, at the same time, there was a complete absence of the sensation of shock and injury to

the ear drum, which even the ·22 rifle is capable of producing. Practically speaking, all shooters are more or less deaf, and the origin of their deafness is the impact of the sound wave, as produced by, and propagated from, the blast of high pressure gas which passes into the air with explosive violence as soon as the bullet has left the muzzle. The Maxim silencer undoubtedly catches this blast, and by the interposition of frictional resistance prolongs the period of expansion, and thereby destroys the power of the gas to initiate a sound wave. What the bullet does is quite another question, but no one's ears would be injured by bullet noises short of lying inside a locomotive boiler whilst shooters were peppering it from the outside.

The actual tests with the service rifle comprised firing it in an open field into a hillock some 200 yards away. The rifle was used alternately with and without the silencer. The various persons present very soon vetoed any further experiments to prove that without the silencer on the rifle, an extremely unpleasant noise was produced by the extra powerful match cartridges, which had been brought on to the ground by the *Field* expert with the idea of making the trial as severe as possible. The silencer certainly destroyed the whole of the unpleasant effects on the ear. On one occasion Mr. Maxim actually stood close to the muzzle of the gun, and held a visiting card for the bullet to pierce, a proceeding which would represent the height of folly in the case of an ordinary rifle. The bullet certainly produced a rending noise as it tore its way through the air, and there was also a decided impact when it struck the bank. Standing adjoining the mound whilst someone else fired produced the strange experience of a sharp crack, probably denoting the arrival of the air wave set up by the passage of the bullet. On the other hand, the air could not separate this sound from the extremely similar one due to impact with the mound. When the silencer was removed, the boom of the discharge 200 yards away followed the first sharp impact thus leaving no doubt in the mind that a person being fired at would hear a crack in the air due to the arrival of the bullet, but with no sound from the firing point to denote whence comes the hostile

fire. The entire abolition of the muzzle report was finally and conclusively proved by discharging a shot vertically into the air. The perceptible noise was then no greater than that of an ordinary spring air gun. A very similar effect was produced by firing into dense vegetation, the bullet being in such circumstances swallowed up by the ground without making any great noise.

It is early as yet to know just what place to give to the new arrangement in the region of practical accomplishments. Other tests must be conducted to prove that accuracy over all ranges remains undiminished, and that the device itself is capable of withstanding ordinary service conditions. One scientific experiment was conducted for the purpose of establishing recoil. The Americans have had first "go" at the invention, and have accordingly examined most of its properties. On the subject of recoil they are, however, vague and almost inconsistent. They variously attribute the diminution of recoil when the instrument is used to 50 and 60 per cent, whereas theory, as understood on this side, suggests that the entire abolition of muzzle blast could not produce so great a difference. The addition of weight to a weapon in itself diminishes recoil, apart from any influence it might exert on the powder gases. The obvious need is, therefore, a measurement of recoil in the fundamental unit of velocity, which permits the elimination of the weight element. Velocity of recoil multiplied by the weight of the weapon gives momentum, and momentum is a constant value independent of the weight of the firearm. The experimental results as detailed below show that, though the velocity of recoil, using the attachment, is decidedly less than that of the plain weapon, the bulk of the difference can be accounted for by the added weight. On the other hand, the Americans report that the velocity of the bullet is greater when the silencer is used than without, due to the additional distance over which the gases may act on the base of the bullet. Time did not permit of separately ascertaining the velocity of the bullet, but it is quite feasible that the extra velocity which the silencer imparts to the bullets adds to the recoil approximately the amount destroyed by modifying the outrush of gases.

However, here are the actual results of the tests that have been completed :—

VELOCITY OF RECOIL WITH AND WITHOUT MAXIM SILENCER.

Kynoch service cartridges ; 30·4 grs. Cordite and 214·8 grs. bullet ; British service rifle, Lee-Enfield short.

WITH SILENCER.	WITHOUT SILENCER.
Net total weight with magazine removed and various fittings added :	Net total weight with magazine removed and various fittings added :
10lb. $2\frac{7}{16}$ oz. = 10·15lb.	9lb. $5\frac{5}{8}$oz. = 9·35 lb.

Difference equals weight of silencer, viz., $12\frac{13}{16}$*oz. = ·8lb.*

1. 7·42 f.s.	4. 8·17 f.s.
2. 7·40 ,,	5. 8·16 ,,
3. 7·38 ,,	...
Av. 7·40 f.s. velocity of recoil.	Av. 8·17 f.s. velocity of recoil.

Comparative recoil in momentum units.

10·15lb. × 7·40 f.s. = 75·1 units.	9·35lb. × 8·17 f.s. = 76·4 units.

Difference in favour of silencer = 1·3 *units* = 1·7 per cent.

Many other experiments will have to be made before an unqualified verdict of approval can be passed. In the meantime it really looks as though success has been achieved in abolishing what has hitherto been regarded as one of the necessary evils of shooting. Whether the idea can be applied to shot guns is far more problematical than in the case of rifles. There are many reasons for supposing that the muzzle blast is the prime factor in producing the dispersion of a charge of shot, and that the shot charge becomes subject to lateral expansion practically from the very moment when it leaves the muzzle. To be effective with shot guns it would be necessary that the silencer should not accidentally catch some of the charge, and since no one is quite certain exactly what happens during the first few inches of travel after the shot leaves the muzzle, the subject remains open until working models have been produced. Instantaneous photographs taken quite close to the muzzle, as a rule, show only a blurred mass of smoke.—(*The Field.*)

A STORY IN SAND.

One evening as the sun was setting, a young tiger rose from his couch of grass beneath an overhanging clump of creeping cane, and after a stretch and a yawn, strolled down to a *nullah* hard by to drink. He was a fine specimen of his race, some nine feet in length, and as he stooped to drink, the mighty muscles of his shoulders swelling beneath his sleek and well kept skin told of a power that few beasts could hope to resist The day had been hot, for it was the month of May, and there is very little breeze stirring in those dense and tangled forests of Assam. So he drank deeply, and then raised his head and gazed around. He was standing on the bank of a stagnant grass-green creek, which wound through the forest from some marshy land a few miles away to his left down to the river half a night's run to the right. It was now merely a lane of short green grass with pools here and there in which myriads of frogs lived, who each evening made the whole air vibrate with their ceaseless chattering over their various love affairs. A few white paddy-birds stood here and there at a respectful distance, watching with outstretched necks, the common enemy. A pair of huge hornbills passed overhead with slow and laboured flight; the quaint rustling swish of their wings clearly heard long after they had passed out of sight.

The sudden sharp bark of a kakur from the dark jungle on the opposite bank of the creek some thirty yards away roused the tiger from his reverie, and reminded him that he was hungry. His hunting had not been successful of late, and for three days he had not tasted food. Deer were not so plentiful now as they had been during the winter months; the gadflies which swarm in millions in these jungles as soon as the hot weather begins, had driven them away. He wished now that he had gone to the hills, as the majority of his kind had done a month ago, instead of being tempted to stay by the number of deer that the succulent green grass in this *nullah* had attracted all the winter. Life had been easy then. He had only had to follow the windings of the *nullah* till he found some sambhur or kakur busy feeding. The *nullah*

was narrow, and it was easy to approach within striking distance without leaving the dense jungle on the bank.

He turned to bite at a leech that was creeping up his leg; when something moving to the right caught his eye, and made him sink down into the grass till nothing was visible but a dull brown streak, which might have been a fallen tree or a patch of naked earth. Some fifty yards away a railway crossed the *nullah* by a bridge. Something was moving along the path by the side of the metals. He watched intently, and in a few seconds a fine young bull buffalo crossed the open space, and vanished on the other side. This railway was a favourite run of the tiger; and many a mile had he run along this path, hunting for the deer which used to come out to feed where the jungle had been cut and burnt beside the line. He had often seen buffaloes that had strayed from the neighbouring villages feeding along the line. But he had never yet attacked them; for the Assam buffalo, whose father or grandfather is often some wild bull that joined the herd of tames ones when feeding in the jungle, is an animal well able to take care of itself. Once when he was young his mother had killed a young buffalo calf that had strayed from the herd; but before the life was out of it, the herd had winded the marauders, and charging in had driven them off their prey. He still remembered the glimpse of lowered heads and mighty tossing black horns bursting through the long grass which he had caught before his mother had told him to fly. The tigers had come back later, when the herd had gone, and had feasted on the fallen calf. But ever since that day he had had a dread of those quiet sleepy looking buffaloes almost as great as he had for the red dogs.

He lay quite still for a few seconds. Instinct warned him to leave the buffalo alone, but hunger drove him on. He would stalk the beast, and taking it unawares would get the fatal grip upon its throat before it was aware of the presence of the enemy. He rose, and silently crossing the *nullah* disappeared into the darkness of the forest on the other bank. The ground was strewn with dry leaves and sticks, which under any other feet would have signalled an enemy's approach from fifty yards away. But he was a past

master in the art of treading silently. He did not walk on tip-toe as foolish mortals do when they wish to walk quietly. He planted his feet down flat and square, and when a leaf began to crackle beneath the foot descended so slowly, that though the leaf was ground to powder by his great weight, a faint rustle audible only for a few yards was the only sign that thirty stone of flesh and bone was moving through the jungle.

Soon he came to the forest edge, and stopped to watch the coveted buffalo. It was walking slowly along beside the line, stopping every now and then to feed on some tempting bit of grass, or to dislodge with horns and tail the swarm of gadflies, which hovering like bees above it descended on either flank immediately the tail ceased lashing for an instant. It was a huge beast with massive, far spreading horns tapering to points as sharp as needles. The tiger, however, his hunger sharpened by the sight, regarded it only as his evening meal. The wind was right, and a glance at the lie of the ground sufficed to show him the best method of attack. Some forty yards further down the line was a shallow cutting with banks four or five feet high; while clumps of high elephant grass, which had half escaped from the fire when the jungle by the line had been burnt, afforded splendid cover for a stalk.

He vanished into the jungle again and a few minutes later a shadow that hardly seemed to move, so slowly did he crawl, left the forest opposite the cutting, and began to cross the twenty yards of open ground between the edge of the jungle and the cutting. So flat did he crouch as he went that it seemed as if it were a flat greyish board instead of a large tiger that kept sliding, sliding nearer and nearer to the edge of the bank. At last he reached the brink, and drawing up his hind legs under him, and choosing a firm place for his feet to grip upon, he lay flat beside a clump of grass, and waited for the buffalo to come. Absolutely still he lay, and only the spasmodic twitching of the last few inches of his tail showed that he was alive. The buffalo came slowly on, all unconscious of its danger. When it was some five yards off, the tiger's claws sprang from their ensheathing pads and bit deeply in the crumbling soil.

The moment had arrived. The buffalo was now directly opposite the tiger, and only some two yards distant. With a low coughing growl the tiger sprang upon the buffalo's neck, and his claws bit deep into the yielding flesh. He had been quick, but the buffalo was quicker still,--or perhaps it was luck that his horn lay between those terrible teeth and the throat they sought. With a mighty toss of his head the buffalo tore the tiger from his hold, and flung him back into the grass he had just left. It was a few seconds before the tiger recovered himself, and by this time the buffalo had broken into a lumbering gallop, and was some twenty yards away. With a fierce growl the tiger sprang down into the path, and rushed in pursuit. All his fighting instincts were aroused, he was no longer the crafty animal hunting for his food, but a furious incarnation of rage thirsting for battle. In an instant he had caught up the buffalo, and had sprung upon his back, and teeth and claws sank deeply in. The buffalo stumbled under the blow, but the side of the cutting saved him from the fall which would have placed him at the tiger's mercy. He regained his feet, and galloped madly forward with the tiger on his back. Then he paused, and lounged backwards with his terrible horns. The point of one caught the tiger on the shoulder, and sinking deeply in forced him to loose his hold. Next second he was hurled sprawling on his back in the dust, and the buffalo had resumed his flight. Blood was now sprinkled freely on the buffalo's track, and the tiger also as he ran left a bright red mark where his left forefoot touched the ground.

Again and again did the tiger rush, but he could not again get home. Each time his quarry was ready for him, and turned to meet him. Again and again he had to stop to avoid certain death on the points of those lowered horns. For a quarter of a mile the running fight continued ; along the track, then up one bank, and then up the other. The gravel was torn up and thrown for yards by the hoofs of the flying buffalo and the claws of the tiger. The smell of the blood spurred the tiger on, but it was of no avail. He had met his match, and at last gave up the pursuit, and limped painfully back to his grassy *nullah*, leaving a trail of

blood from his wounded shoulder behind. This was the story, I, the hunter, read one day in the sand by the side of the railway line. It was written as clearly in Nature's book as it is upon this sheet of paper. As I stood and looked upon this record of the struggle, I felt that I would have given much to have been permitted to see such a fight between two of God's grandest creatures, —(*By Wandringgun in the Indian Field.*)

MISCELLANEA.

PAPER-MAKING IN INDIA.

In the course of a review of Mr. H. W. Emerson's Monograph on the papier-maché and paper-making industries of the Punjab which we published some weeks ago, we pointed out that as wood-pulp in foreign countries become more and more difficult to obtain, and consequently dearer in price, many think a good time will come for Indian paper-makers. This opinion appears to be held also in influential quarters in India, for it is stated that official aid is to be given with a view to placing the paper-making industry on a firm basis, and that the Imperial Forest Research Institute is about to take steps to demonstrate the practicability of wood-pulp for India. A contemporary, writing in this connection recently, stated that " it has been known for many years that the necessary materials in the shape of fibres, grass and bamboo are procurable in abundance practically all over this country, and the cost of labour is far below that prevailing in any country now competing for the paper trade of India." It is, however, a great mistake to think that all that is required to establish a paper-making industry in a given spot is an abundance of fibrous material and cheap labour. The paper fibre and pulp expert tells us that the finest natural supply of raw material in the world may be valueless unless it is associated with the manufacturing factors necessary to financial success, which really require even more careful surveying and testing than the raw material itself. In this connection it is to be hoped that the official aid to be given with a view to placing the

paper-making industry in India on a firm basis will be more productive of results than was the effort made a few years ago, when Mr. R. W. Sindall was sent out by the India Office to investigate the suitability of Indian fibres for paper-making purposes. The latter was a well-known consulting chemist and wood-pulp and paper trade expert, and the account of his investigations which was published in the form of a report was very interesting; but it was not exactly what was wanted. The Government of Burma, no doubt with the best intentions possible, employed this expert chiefly on an investigation as to whether bamboos would make good paper, whereas it was well known that they would do so quite 30 years before. On the other hand, little light was thrown on the chief problem of whether Burmese bamboos would make money as well as paper; and the consequence is that Burma's bamboo forests still remain unexploited as far as the paper-maker is concerned.

What the capitalist wants to know is where he can manufacture successfully, the conditions under which he will have to work, conditions of the quantity of raw material available, native chemicals, labour, freight power, fuel, water, natural facilities and advantages of sites, etc. He says, reasonably enough, that he is willing to risk his capital provided he can obtain this information beforehand, but that it is the business of the various Governments concerned, the big landowners and others who have got bamboo to sell, and who desire to see new industries established in their territories, to take some steps to advertise what they have got to offer. What is wanted are accurate surveys by competent experts to determine, not whether bamboos, etc., will make paper, but the whole and complete pulp-making possibilities and facilities of the territories and districts where bamboo is already known to exist in abundance. It must be explained that the modern paper-maker's trade is divided into pulp manufacture, and, secondly, paper-making proper. This has greatly facilitated the manufacture in countries distant from the centres of consumption by eliminating the cost of freight on waste material. It is no longer necessary for the paper-maker to import from two to three tons of raw material for every

ton of paper he produces. It suits the paper-maker to be close to his consumer, but the pulp-maker's chief interest is to be near his raw material. This he reduces to pure cellulose or pulp, technically known as "half-stuff," or half-made paper, eliminating from it the 50 to 60 per cent of waste; and this pulp he exports to the paper mills situated near the eventual consumer of the finished product.

"The consumption of paper," said Gladstone, "is the measure of a people's culture." Measured by this standard "culture" has increased from under 30,000 tons in 1860 to 8,000,000 tons in 1907. This enormous increase has been made possible only by the utilisation by the paper manufacturer of wood as a raw material. Of the 8,000,000 tons of paper now used annually 6½ millions is produced from the spruce and soft pine timbers of Northern Europe and America. It is said that a single London "daily" will eat up 6,000 acres of forest in a year; and that in ten years an area of the world's forests equal to the whole of Scotland has been swallowed up by the Newspaper Press. The growth of consumption during the last 20 years has been so breathlessly rapid that little or no attention has been paid to the conservation of supplies, and the fact that spruce is within measurable distances of extinction has come as a shock, even to many of those engaged in the trade. Nothing, however, is now more generally recognised in the trade itself than that a paper famine is imminent, unless a substitute is found. Such a famine would be much more serious than one concerned with an article which takes only a year or two to mature, for spruce takes at least 30 years to grow and does not reproduce itself under ordinary circumstances, every tree cut being the permanent loss of a capital asset. In the United States the exhaustion of the spruce and pine forests is so complete that the mills there are now drawing their supplies from Canada; and in the Scandinavian countries the depletion is so serious that forests are now at great distances from the mills, and the water-power upon which manufactures of all kinds so largely depend has been seriously affected. The matter is considered very serious in America, and a short time ago the Government appointed a Commission to enquire what possible substitutes were available. The Commissioners

reported that, so far as United States territory was concerned, there was none worthy of serious attention, and in despair of finding a solution within their own borders, they seriously considered the question of economy in the use of paper, and submitted a series of proposals, "whereby," to quote their own words, "$2\frac{1}{4}$ million tons will do equally well the service now performed by 3 millions." Pessimism could scarcely go further than to propose to cure the ills of an industry thus by curtailing its production and scope.

The object-lessons of complete exhaustion of the spruce and pine forests in America and serious depletion elsewhere are no longer being ignored by the Governments who still possess large reserves. Canada in particular has embarked on a policy of severe restriction aimed at conserving her resources for future timber, rather than present paper supply. Thus, to exhaustion in one direction is being added restriction in others, and the net effect is, to quote the *World's Paper Trade Review*, the leading organ of the trade, that "wood-pulp has reached its limits of expansion, and to maintain the present growth of paper consumption an additional source of material must be found." Fortunately the world is so rich in paper-making material that absolute famine is unthinkable, although there may be considerable scarcity while the slow process of transferring the industry from its present locations to a new and largely different set of conditions is being accomplished. In India alone, more material is said to be wasted annually in forest fires than would supply the world several times over. Mr. W. Raitt, who has devoted several years to the study of the exceptional facilities for pulp manufacture afforded by India and Southern Asia generally, and has been contributing a series of interesting articles* on this subject to the *Tropical Agriculturist*, reports that in Himalayan spruce, bamboo and certain fibrous annual grasses, there is sufficient raw material available in India to produce hundreds of millions of tons of paper annually, and since the bamboo and grasses are self-reproductive there is no danger of their exhaustion, as in the case of spruce. But he, too, repeats the warning, given expression to above, as to raw material being

* These are reproduced on p. 34 of this number.—HON. ED.

by no means everything, and as to the need of the capitalist having a careful survey of the manufacturing factors necessary to financial success made before deciding to incur any larger outlay.

Since it appears certain that a considerable amount of the capital now employed in pulp production must be gradually diverted from Europe and America by lack of supplies, it would seem desirable that those countries possessing natural facilities for such manufacture should make a bid for the trade which will thus be going a-begging, which trade will naturally drift to the localities which can make the best display of their resources. It is pretty well known at present that in South America, Africa and Southern Asia there are unlimited supplies of raw material capable of making paper, but scarcely anything is known as to whether the conditions, under which it exists, are such as will render feasible the making of both paper and money. It would seem, therefore that if India wishes to make a bid for this trade, the authorities should lose no time in embarking upon a thorough survey and exploration of her resources in this direction. This, as stated above, is primarily a matter for Governments to undertake, but much could be done also by local authorities and landowners who possess reserves of material, finding out and making known what they are worth. In this connection India should take a hint from the United States, where the Government, as soon as they realised that their domestic resources were approaching an end, instituted an inquiry and investigation regarding those of the Philippine Islands, and this is now being conducted.—(*The Madras Mail.*)

GOVERNMENT FORESTS OF JAVA.

Mr. E. Tobi, Chief of the Forest Service in Netherland India, writes as follows in the *Timberman*, of Portland, Oregon, on the Government forests of Java :—

" In the island of Java there are 1,665,000 acres of Government forest—principally teakwood. They are primeval forests, more or less damaged by dishonest fellings. Three hundred and sixty

thousand acres of them consist already of plantations. Nearly all these forests are worked on working-plans. In the greater part—1,545,000 acres—the management is not so thorough, as forests are felled there by contractors. In the remaining part—120,000 acres—management is effective, the timber being cut by the Forest Service. The area under effective management increases yearly, and consequently the fellings by contractors will decrease in future In 1907 the teak forests yielded 175,000 tons of timber, of which 129,000 tons were cut by contractors, 39,000 tons by the Forest Service, and about 7,000 tons by others. The yield of firewood and fuel was 27,000,000 cubic feet (stacked).

"Government felling was started in 1897. In 1905 these fellings yielded 26,000 tons of teak timber, the next year 36,000 tons, and in 1907 the yield was 39,000 tons. Fellings by contractors yielded in those years 120,000, 116,000 and 129,000 tons respectively. Nearly all forests being worked on working-plans, it cannot be expected that the annual output will increase by increased felling of forests.

"Contractors arrange for the exploitation of forests with a yearly supply of about 1,400 tons of timber for five to eight years. They pay a certain sum per month or year, or at a rate per ton of timber yielded. The exploitation of these forests is mostly determined by open contract, a great number of such forests being in the hands of a few companies, who sell the timber after its arrival in depôts, or export it. The timber supplied by the Forest Service is mostly sold in public auction, the supply of some Government depôts being sold by public tender.

"At the beginning of 1908 the Government started an experiment with a donkey engine that was ordered from Seattle. Prior to this time all the timber had been hauled to the roads by buffaloes or by men. The transport from the forest to the nearest railway or great river is done along logging railroads or on buffalo cars. Floatable streams are scarce in Java. Most of this timber is hewn into balks that are made in the forest with the axe. However, in the last few years the production of logs has been growing into practice.

"The export of teak timber in 1907 was 47,000 tons, distributed as follows :—Twenty-four thousand five hundred tons to Europe, 3,600 tons to Asia, 18,000 tons (mostly sleepers; to Africa, 650 tons to Australia, and 150 tons to America. One hundred and twenty-eight thousand tons were used in Java. The export has increased of late years. In 1903 it was 20,000 tons ; in 1904, 22,000 tons; in 1905, 43,000 tons ; in 1906, 46,000 tons, and in 1907, 47,000 tons. Besides the teak forests Java has wild wood forests of considerable extent. All wood that is not teak is called wild wood here. However, the good timbers have disappeared from most forests. They occur still in the mountains, but transportation is difficult there. Besides, many of the mountain forests have been reserved for climatological and hydrological reasons.

"In the other islands (Sumatra, Borneo, Celebes, etc.,) there is no forest management deserving the name. However, the Government is considering the exploitation by contract in the island of Sumatra of a great forest area. Of course, it would be necessary for capital to interest itself in this enterprise. Steam logging appliances and saw mills and export on a large scale would be necessary conditions for success. There are still enormous areas covered with forest on these islands. Thus, if the experiment should be tried and prove a success, exploitation could be greatly extended there. Teak timber forms so inconsiderable a part of the forests there as to be underserving of mention. The forests contain a great variety of tropical timber, the main difficulty consisting in finding a market for it."—(*Timber Trades Journal.*)

FORESTRY IN JAPAN.

To the lover of trees nothing could be more charming than a visit to Japan. There the variety of tree growth is remarkable, ranging, as it does, from the purely tropical, through the various stages of subtropical, to the temperate conditions to be found in the northern parts, the latter area being, perhaps, of most interest to the Englishman. I was enabled through the courtesy of Mr. Shirazawa, Professor of Forestry in Tokio, to enjoy a visit to some

of the forests under Government supervision, two of the most famous of which are those of *Cryptomeria japonica*, at Akita, and of *Thujopsis dolabrata*, at Aomori. I need not enter here into any account of Japanese ways or formalities, interesting though they are, but I may say that wherever I went I was treated with the utmost consideration and kindness. I set off one morning at six o'clock, from Odate near Akita, accompanied by two forest officials. We boarded a truck on a light railway, which, starting in the area of cultivation, took us gradually up through the rolling foothills, once clothed in forest, but owing to the ruthless felling of old days and to fires, now but rough grazing ground, to the saw-mill at Kosaka, where the real forest begins. Along the banks of the river up which we had come I had noticed stains of blue and green, where the banks had been washed away, so was not surprised to find at Kosaka a copper mine, the largest in Japan, the fumes from which, in some unaccountable way, affect the health of the *Cryptomeria*, and have killed the trees outright in some places. The forester in Japan has no rabbits to contend with, as in England; no deer, as in Germany; and no big forest fires, as in America and India; and although he may have a very heavy fall of snow in winter, 4 ft. being the average depth in these parts from November to March, it does not appear to do much damage, and is of great service in affording slides to get the timber down the mountain sides, and in making good sleighing along the tracks to the saw-mill. The Japanese make the most of this by doing most of their felling in winter, but there is also a light railway, of 2 ft. 6 in. gauge, for summer use; and after an inspection of the very up-to-date saw-mill, we set off again along this in a trolly pushed by two sturdy little Japanese woodmen. I could not do more than see part of this forest in one day, as it comprises some 30,000 acres, but the part which we now reached as we ascended the valley, with steep slopes rising on every side, was some of the best of it. It was noticeable that much of the best growth was on the north and west slopes, and to a moisture-loving tree like the *Cryptomeria* this is not to be wondered at, as the prevailing wind is west, bringing with it rain from the sea of Japan,

and I was told that 300 cubic feet of timber grew on the northern slopes to 200 on the southern. Much of the ground is so steep that it cannot be heavily stocked with timber, and considering that it has only been under scientific management for twenty years and that it is virgin forest, except for the elimination of the broad-leaved trees, it is surprising that there are so many splendid, straight-growing stems, which are also particularly free from branches, considering the distances they stand apart. Some of the trees were 100 ft. high, and 9 ft. to 10 ft. in circumference, five feet from the ground.

This forest is managed for the most part on the uneven aged or selection system, but here and there where a clear cutting has been made the ground is planted up after three years with three-year-old trees, from one of the many nurseries, at a distance of six feet apart, and at a cost of £2 10*s.* an acre. Two things struck me about this: (1) that the young trees should be planted so far apart—but this was apparently explained by there being no demand for thinnings; what demand there is coming, as it does, mostly from the big towns, being met by the forests in the south, near Osaka; (2) that they should wait three years before replanting. This I was unable so get satisfactorily explained, as apparently they feared nothing from insects, and it gave the undergrowth, which is considerable compared with that of the more closely grown German forests, such a start, that it has to be cut back each of the succeeding years, at a cost of 8*s.* an acre. It may have something to do with soil decomposition. The wood of the *Cryptomeria* is very valuable for building, and the best quality at present fetches 8*d.* per cubic foot, though, considering the increasing demand in China, and the very limited sources of supply there, it is reasonable to suppose that this figure will soon be exceeded. The firewood is easily disposed of, and the bark is sold at 1*d.* for 4 square feet for roofing, which, owing to the low rate of wages, pays well enough.

Perhaps, in conclusion, I may give a few figures for any who may be interested: The rotation adopted for the *Cryptomeria* is 100 years, and the greatest age 160 years. At the present time

the total estimated contents are 164,500,000 cubic feet of timber on the 30,000 acres, the yearly increase 111 per acre per annum or 3,330,000 cubic feet annually, and the yearly yield 1,925,000 cubic feet, on which the net receipts are £12,000, giving a profit of 8*s.* per acre per annum, which, it must be remembered, represents more out there than here, and which will go on steadily rising, as the forest comes into full bearing.—*(By L. R. Hargreaves in the Field.)*

GOATS AND AFFORESTATION IN ST. HELENA.

The abnormal deforestation which has taken place in St. Helena during the last 300 years is, states Governor Gallwey, entirely due to the ravages of the goat. It is the Colonial Government's impoverished condition only that has prevented him from strongly urging the introduction of legislation by which every goat in the island would be exterminated, and the importation of that animal rigidly prohibited. A privilege too long granted is generally abused by an easy-going community, and such privilege in time is looked upon as a right, although not legally one, the withdrawal of which would be considered a gross piece of injustice. This fact applies to the roaming of large flocks of goats over Government waste lands in St. Helena to-day. With the exception of a few wild goats on the Barn, all these animals are owned. If, therefore, an order went forth for the slaughter of all goats, it would be only reasonable to grant owners some compensation for the loss of their animals. The Governor is convinced that once the goats were eliminated from St. Helena, it would be found quite easy to plant most of the waste lands, which are now such eyesores, with willow and other hardy trees. He agrees with the opinion of the leading landowners in St. Helena in 1810 that "the temporary inconvenience of a few ought not to be an obstacle to the permanent interests of the island." The landowners referred to unsuccessfully urged the destruction of all goats. In the year 1502, when the island was first discovered, its interior was described as one entire forest, and even some of the cliffs overhanging the

sea were said to be covered with gumwood trees. The Portuguese, unfortunately, introduced goats into the island in 1513, and in 1588 Captain Cavendish relates that "there were thousands, and they were seen one or two hundred together, and sometimes in a flock almost a mile long." The early explorers of St. Helena refer to "huge forests," few vestiges of which are now to be seen, thanks to the goats.—(*The Field.*)

FORESTRY IN NEW SOUTH WALES.

The Wade Government, with the intention of conserving the existing forest reserves and providing for their regeneration and treatment in the interests of natural reafforestation, has passed the Forestry Bill creating a department and extending the principle of issuing licenses. The Government is empowered to grant exclusive rights to work large areas. All saw-mills must be licensed, and power is given for the proclamation of comprehensive regulations embracing all phases of forest management. The Government forest reserves in the coastal and central districts make an aggregate of upwards of 7,000,000 acres, containing large supplies of magnificent hard woods and ornamental soft timber.—(*Reuter.*)

SCIENTIFIC PAPERS.

ON THE CULTIVATION OF DWARF RUBBER TREES, Etc.

The pioneer rubber cultivators in the East have turned to excellent account economical methods of culture which afford specific guidance to planters in other parts of the world. The Para rubber species which is almost exclusively cultivated is a stately tree, so that on planting wide spaces intervene between the plants. Interplanting is therefore methodically resorted to. Amongst other products tea and cocoa are extensively intercropped. In Ceylon, says the *Times* in a recent issue, rubber plantations now occupy an area of 180,000 acres, "tea and rubber are interplanted over 60,000 acres, and cocoa and rubber over 12,000 acres." The returns for the intercrops go a long way to recoup the expenses attendant upon rubber cultivation. At the same time some doubt is entertained as to the utility of interplanting, as it seems to check the development of rubber trees.

Tea production is peculiar to the East. But cocoa and Para rubber are indigenous to tropical America. I may here relate an interesting episode to the effect that Jamaica was working on parallel lines with Ceylon a generation ago in respect of tea, cocoa and rubber. But the contrast is great between then and now. The cultivation of both tea and cocoa was started on a commercial scale in Ceylon just at the time I started both cultures in Jamaica. In 1868 I received from Calcutta through Kew a Wardian case containing 600 plants of the Assam tea plant. They were propagated and an acre of them planted, and samples of tea I had made I exhibited at the Philadelphia International Exhibition in

1876. It is now being successfully cultivated and manufactured on a small scale by an enterprising resident. Then Sir Joseph Hooker, the distinguished Director of Kew Gardens, suggested to the Governor of Jamaica, Sir J. P. Grant, the advisability of introducing the best varieties of cocoa. Accordingly I was deputed in 1873 to investigate the cocoa enterprise in Trinidad, I imported thousands of seeds and they flourished. It is now a product of considerable importance in this island. Again a few years later rubber was suggested by Sir Joseph Hooker. I thus imported several important species in the seventies, including a case of plants which accompanied me from Kew on a voyage to the island in 1877. I was engaged at the time in planting hundreds of acres of cinchona in the Colony, a step promulgated by the Colonial Office at the instance of Sir Joseph Hooker and Sir Clements Markham, the latter having made a famous voyage to Peru to secure plants and seeds of this important tree which has since been cultivated with wonderful success in the East, particularly in Java, to the soil and climate of which it is peculiarly adapted. At this time the cinchona planters of the East had sufficiently established their new industry to preclude the possibility of the permanent commercial existence of a new genus of quinine-yielding trees, *viz.*, Remijia, of which great forests were discovered in Colombia. The richer bark of cinchona, and its cheap production saved the eastern planters. Hence as Ceylon rubber cultivators, bearing in mind their indebtedness to Kew, have derived many practical lessons from their cinchona cultivation which they conducted on scientific principles, it may be interesting to reproduce here the following paragraph from the *Tropical Agriculturist* dated July 1st, 1881:—

"Cinchona Seed.—Sir Joseph Hooker has received an important communication from Mr. Robert Thomson, formerly Superintendent of the Cinchona Plantations, Jamaica, but now resident at Bogota, in which an account is given of a new kind of cinchona (Remijia), the cultivation of which in British possessions may prove to be very desirable. The bark, which is now a considerable article of commerce, only contains two or three per cent of quinine.

Mr. Howard however says that 'the quinine, though not abundant, is pure.' Its botanical origin is at present unknown, but according to Mr. Howard the bark is known as *China cuprea.* The important feature about this species from the point of view of cultivation is the elevation above the sea at which it will grow, its native range being from 2,000 to 3,000 feet. Sir Joseph Hooker is extremely anxious to obtain seeds and plants of the new species with the aid of Mr. Thomson. In the meantime Mr. Thomson is anxious to procure in some quantity seed 'of the fine kind of *Cinchona officinalis* spoken of by Mr. Howard that grows in the Nilgiris.' The Conservator of Forests, Madras, has been desired by Government to forward direct to Mr. Thomson an adequate supply of seed of the fine kind of *Cinchona officinalis* which grows on the Nilgiris. On receipt of intimation by Government of its despatch, the Secretary of State will be informed accordingly in view to Sir Joseph Hooker's services being enlisted for obtaining plants of the *China cuprea.—Madras Mail.*"

Adverting to the rubber-growing resources of Jamaica, all the climatic conditions of a vast tropical territory are represented in the island. Plants that flourish in hot dry zones of the earth, and *plants that flourish in all gradations of humidity, culminating in* 200 inches of rain per annum, all find here a fitting home. In other words, in this island with its 4,000 square miles of land the conditions are so varied, that if it is necessary to plant a given species of rubber in a hot semi-arid zone here we have all the desired environments concentrated (the Manicobas). If a zone of moderate or excessive rainfall is most conducive to the welfare of another species, it is only necessary to make a selection in a locality near by. And if totally different conditions of temperature are most congenial for other species, we have only to deviate our course up a high mountain there to secure a temperate climate. Of course the climatic conditions must be backed up with congenial soil. I mention the splendid resourcefulness of Jamaica because my sympathies are naturally drawn towards it.

After my retirement from the Colonial Service I lived many years in a rubber forest in the Republic of Colombia on the fringe of

the great forest intersected by the Orinoco and the Amazon. There it devolved upon me to form a large plantation in conjunction with the wild trees, the Colombia *Virgen* species. That was long before the rubber craze came to the front. After the establishment of this plantation, probably the first large plantation in South America (1882—86) though the trees flourished exceedingly, the plantation was deemed of secondary importance to the splendid surrounding cinchona plantation I had also formed, and the rubber plantation was completely neglected for many years, the same fate befalling the cinchonas. In recent years, however, the rubber plantation has been reclaimed. I may mention that I have recently supplied hundreds of thousands of these seeds for distribution to various countries, including Jamaica. I found this rubber tree at great elevations on the Colombian Andas. Hence it is adapted to warm temperate climates, with a temperature ranging from 45 to 80 degrees. It is, therefore, cultivable in warm regions without the tropics.

We know what has been accomplished with rubber in the East. All attention has been devoted to one species selected for cultivation on a great scale out of scores of species scattered over vast regions of the world. It remains to be seen whether some untried species is not equally amenable to successful cultivation, even with some peculiar advantage in its favour. Now I have great faith in various species of *Manihot* (Manicoba), one of which I had the good fortune to investigate in its native habitat.* With another species of *Manihot*, a starch-yielding species, I have had considerable experience having stimulated its cultivation for starch production. And from the fields I had under cultivation, embracing many varieties I collected in Colombia, I supplied great numbers of cuttings to the U. S. Department of Agriculture, India etc. The rubber-yielding species of Manicoba are small trees, and the one I investigated I regarded in its yield of rubber, per acre as being "second to none" when brought within the pale of systematic cultivation.

In order to point out one or two of the advantages of cultivating this dwarf tree, I subjoin the following quotation from my

* *Vide* the article on page 1 of this volume.—HON. ED.

pamphlet, and I wish to lay great stress on the facts related. A gain of several years in the production of crops is an important factor. Another is the moderate cost of upkeep. Some day the rubber planter will learn the difference between a tree with a huge trunk and a small tree whose vital functions are not concerned in the production of great logs of wood :—

"Again, the humble dimensions of the Manicoba tree, I am convinced, is a factor in its favour from a cultural point of view, for it attains to a size exactly suited for close planting. In the great *Hevea* (Para rubber) plantations under cultivation in the East, close planting is systematically resorted to with the object of forcing early crops which are available from young trees of limited size, for numbers collectively far more than compensate for the production of rubber per acre from full grown trees widely planted. As a matter of fact, big trees are stated in the East to be an encumbrance. The number of trees usually planted in the East run from 100 to 200 per acre, sometimes more. The number of Manicoba, I advocate, to be planted is 1,200. I estimate that 1,200 trees per acre (exclusive of certain returns in the fourth year) will yield 600 lbs. of rubber in the fifth year ; and at least the same quantity annually thereafter for a long period of years."

Even in England we have a parallel example of the utility of close planting. A practical fruit-grower, writing in the *Standard* newspaper a few weeks ago, says on this point : "At home the production of the apple has increased by leaps and bounds, thanks to the substitution of the dwarf for the old-fashioned form of standard trees." The writer of this interesting paper has been good enough to furnish me with further particulars on this point :—

"The two forms of trees referred to were dwarfs, either bush trees or pyramid trees, and the ordinary tall, long-stemmed standard fruit trees. The last named are practically twice the height of the former. Often they are higher still. The dwarf trees can be cultivated from start to finish by hand, and in the harvesting period all the fruits can be hand-gathered without fear of fruit buds being injured, etc. Standards are planted about 24 feet apart at rate

of 75 to the acre, dwarfs at 12 feet apart, each way 312 trees to the acre."

The dwarf species of rubber involved in this method are new to cultivation. In this connection it is noteworthy that the Para rubber species is acknowledged to be too majestic, and it has been suggested that effort should be made to curtail its dimensions by cultural treatment. Some small trees of great economic value are treated in this way in the tropics. Coffee and tea, for example, are kept down by means of pinching and pruning, and the productive capacity of the plants are not impaired thereby. But the great Para rubber tree cannot be tampered with or adjusted to suit the notions of cultivators, though such treatment appeals to the dwarf Manicoba. The power and skill of the Ceylon planters are strong enough to concede this advantage to the Manicoba. Moreover, totally different climatic conditions appertain to the latter. And varieties of great excellence distinguished by their good constitution and productiveness will be treated. Thus the dwarf rubber trees will no doubt enlist numerous cultivators, and belated planters will be benefited. Adverting to coffee and tea it may be noted that the average rate of yield is for the former in Southern India about 3 cwts. per acre, and for the latter in Bengal and Darjeeling barely this amount. India contains a vast area of land climatically adapted for Manicoba trees. And I estimate a higher yield of rubber per acre therefrom than the produce from the other cultures. Thus rubber may be cheaply produced some day.

In this connection I think it will be interesting to prospective planters of the Bahia rubber species to take into account the possibilities of another distinct method of culture which entails a higher pitch of cultivation than that I have dealt with, indeed an appendage to all existing systems of cultivation. This alternative method of cultivation might, at all events, be experimented upon by enterprising planters of dwarf-growing species.

The height of the largest Bahia rubber trees I encountered in the forest barely exceeded 25 feet, and this was several feet above the average. (This is only one-fourth that attained by a full

grown Para rubber tree.) Between 15 and 20 feet sturdy young trees abound in coagulating latex. And no doubt the best success will be obtained with comparatively young trees. They are more or less influenced by the shade of other forest growth. Such trees, under favourable circumstances, could only be three years old—at any rate if under cultural care. It is these favourable circumstances that have to be drawn upon. Based on the system of culture relative to which I herewith reproduce extracts from my pamphlet on "Pineapple and other Products of Florida" (published officially in Jamaica), an ingenious system of plant-growing with which I was struck, is susceptible of being turned to important account with dwarf rubber trees. Another advantage to be derived from this system is that the dwarf rubber plants may be planted some five feet apart, 1,742 to the acre; and the dwarf trees thus cultivated may be made to yield returns in three years.

My references from Washington included one to the pioneer of a new system of pineapple cultivation. Acres of sheds were constructed by this pioneer (Mr. Russell), and he commanded success. This system of cultivation is now exclusively adopted at Orlando, partly to afford protection from frost and partly to screen the pineries from the burning sun. Thus numerous pineries, ranging in size from one to twelve acres are closely boarded all round 7 to 8 feet high. At regular distances posts are placed some 12 feet apart, on which are fixed connecting rods; on these are placed narrow rafters between each of which a space similar in width is left for the admission of light. Through these spaces the light is admitted in glittering rays of sunshine, ample, it is abundantly proved, for the well-being of the plants. A still more remarkable feature of cultivation is demonstrated under these sheds, one that futher exemplifies the constitutional flexibility of this plant. During several months of winter when frost is dreaded, when every hour of night is watched for possible disaster by all concerned, the whole of this shed structure is covered with canvas, sometimes even with laths fitted in the interstices of the fixed roof laths, with the result that all the plants in the interior are shrouded in comparative darkness for several months.

The cultivation under sheds is a remarkable success, it is not only perfect garden cultivation, but it rivals the most skilfully conducted greenhouse cultivation. Nine thousand are planted to the acre, every plant, practically speaking, flourishes. It is not uncommon to see a pinery with 95 per cent bearing fruit. The average is 80 per cent. The soil is an important factor. It is nearly all sand containing as it does from 96 to 98 per cent of silica. The growers furnish all the food by fertilisers which bring forth luxuriant crops. The fertilisers are manipulated and applied with scientific precision, just what is desired to ensure complete productiveness.

There are at Orlando alone about 200 acres of cultivation under sheds. Large extensions are made annually. At the time of my visit, there was one application for 100,000 suckers. A one-acre or a two-acre shed (and there are many such) is considered a lucrative investment for planters. The larger cultivators have sheds occupying from five to twelve acres each.

The cost of erecting sheds per acre averages fully 300 dollars and for the canvas as much more. They last about seven years. Suckers cost 10 cents each 9,000 per acre (900 dollars). The fertilisers cost about 100 dollars per acre annually. Thus an acre costs fully 2,000 dollars on the first crop. The first crop in about 20 months covers all expenses.

The suckers are set in long beds, usually with 7 in the cross rows, 18 inches apart, and from 22 to 24 inches between the rows. The sandy soil is kept perfectly free from weeds by means of a scuffle hoe every fortnight, with which also the fertilisers are turned in two or three times a year. This hoe is worked from the passages on either side of the bed.

The shed method has thus brought to light new cultural possibilities of the pineapple. Darkness, during several months of winter at Orlando, does not interfere with the perfect cultivation of the plant. Interrupted sunshine throughout the year by means of sheds for both varieties enhances the luxuriance, productiveness, size and flavour of the fruit, and the cost of fertilising is materially reduced thereby.

One great grower to whom I was referred by the Department of Agriculture informed me in the presence of another leading grower, that he had from the first confined his attention to 10 acres of sheds, he could have done better than by cultivating 60 acres in the open. Most of his cultivation is now under sheds. And the consensus of opinion is markedly in favour of shed culture.

Oranges, too, succeed perfectly in sheds, but the lofty structures requisite are expensive. I have seen dozens of acres. Horticulturally the system ensures the most vigorous development of plants.

The conclusions I arrived at with regard to the actual benefit conferred on plants by the adoption of shed cultivation, are as follows:—It mitigates the fierce burning rays of a tropical sun upon plant-life. It prevents continuous and excessive evaporation. It interrupts the force of winds which conduces to increased evaporation and aridity. Thus the whole mass of plants within creates atmospheric conditions of their own, conditions which are suffused throughout the shed.

In another paragraph I suggested that strong climbing plants trained on wires might be substituted to a certain extent for laths in the tropics. Protection from climatic vicissitudes would thus be afforded, and protection is an important factor. This manner of cultural treatment in the case of Manicoba merits attention. Experience alone can prove the best height at which the plants should be maintained—probably fifteen feet.

R. THOMSON.

October, 1908.

[In forwarding the above the author states that in his opinion great tracts of the dry regions of India would be eminently suitable for the culture of the Manicoba rubber tree. The establishment of a great rubber industry on the dry unirrigated lands of India would become an important adjunct to the industrial development of the country. Few products, he says, are of equal importance, and the people of India are eminently qualified to accomplish this great undertaking.—HON. ED.]

ORIGINAL ARTICLES.

TEAK IN BURMA.

In the October number of the *Indian Forester* Mr. Troup raises the question of a more uniform system for teak combined with improvement fellings; and at the end he invites discussion of the subject. This must be my apology for venturing on to ground so shaky as to afford little support other than that of opinion.

2. In para. 3 of the memorandum and para. 23 (3) attention is drawn to the area sometimes prescribed for improvement fellings, and to the diffidence shown by some working-plans officers in laying down what appears impossible of execution. The difficulty of carrying out improvement fellings has been habitually exaggerated. Two divisions in Burma last year managed 23,000 acres of good work between them. I am in thorough agreement with Mr. Troup about the possibility of organising several parties working independently. I have trained working plans demarcators and enumerators, road-foremen, plantation-mappers, and supervisors of improvement fellings, and I have no hesitation in asserting that men of sufficient intelligence, energy and will are to be found in Burma in ample numbers, provided they are well paid and decentralisation is carried far enough to allow the divisional forest officer a reasonably free hand in selecting and paying his men. The weak point is more likely to be found in the energy of the D. F. O. and in his powers of selection than in the possibility of obtaining good men.

3. In para. 4, successive tending operations at intervals of six—eight years are suggested. This seems to me a little long, and I would be afraid of spoiling the ship for a ha'porth of tar. A freed seedling could not well perish by suppression in five years nor even suffer great loss of vitality, though a longer period under the domination of overgrowth might injure its power of recuperation. The

operations having for their object a direct enhancement of increment per unit of area should be separated from those intended mainly for protection. The former require a comparatively high degree of skill, while the latter can be carried out efficiently by any intelligent and trustworthy subordinate.

4. This question of concentration leads to another consideration; if by spending Rs. 1,000 we can get up to maturity 1,000 additional trees, is it better that these 1,000 trees should be distributed over 150 acres or collected on 20 acres? The answer for the well-being of the forest is probably in favour of the former way of spending the money. But it is likely that the problem is not fairly stated. If 1,000 additional trees can be ensured on 20 acres, the same sum will not be enough to operate over 150 acres, and instead of 1,000 trees perhaps only 700 can be expected. Still this is an aspect not to be overlooked.

5. Here perhaps a word of protest may be entered against the tendency of Mr. Troup's memorandum towards "teak, all teak, and nothing but teak." In our present lack of knowledge we are not justified in reducing the number of trees grown, in eliminating any single species. We know little about the properties of the different timbers, less about the sylviculture of the various species, and less still about what the future may require of us. The increasing facilities of transport (monorails, pedrails, aeroplanes, etc.), and the advance in the methods of utilising timber for almost any purpose (pulp, silk, yarn, matches, impregnation) may render any step in the direction of dogmatism about the uselessness of certain species costly beyond expectation. We know that teak is valuable, and is likely to continue so; this justifies us in increasing the proportion of teak in our forests, but not in interfering with the degree of representation of trees whose merits we may be unable yet to appreciate.

6. Teak is sporadic, not gregarious; this must constantly be borne in mind when considering the adoption of any system for regenerating the present naturally mixed forests. Dense crops of pure teak are unnecessary and dangerous. As an ideal at which to aim for the average forest one teak to five other species appears

a reasonable proportion ; it is as well to fix some standard for guidance. A crop with this proportion of teak or a higher one should be considered to be without need of special assistance.

The question arises whether an even-aged mixture or some method of two-storied high forest is preferable. The tendency in Europe now seems to be in favour of pure groups of limited area with underplanting at time of principal height-growth if necessary. We seem to be in the position of Hobson. Whether we like it or not, owing to the size of our forests, we shall be unable to grow anything like two-storied high forest on a large scale for some time yet, though it seems not improbable that this method may turn out the best for teak. But without further knowledge about the minimum degree of admixture needed to render a crop safe against serious insect or fungus plague, and about sylvicultural characteristics of species to be underplanted, it is unsafe to go beyond experimental work in this direction.

7. Any method of working now introduced must be looked upon as empirical and tentative until the establishment of local stations for scientifically compiling some of the facts of the sylviculture of Burma has been officially recognised as essential. To obtain a sound sylvicultural basis to our work, forest-gardens and experimental parks are needed at Pyinmana, Rangoon or Tharrawaddy, Maymyo or Taunggyi, and Bhamo. Questions to be settled at these stations are—rate of growth, even-aged and pure ; relative demands on light, moisture, soil, mineral food, power of resistance to fire ; effect on the soil of each species, degree of density ; methods of sowing, etc., etc., while the parks would provide arboricultural specimens of different trees and furnish seed. How we have managed to avoid forming these experimental stations appears to me almost inexplicable. What his workshop is to the engineer and his laboratory to the scientist such is his experimental area to the forester. And in a country like Burma with 1,500 woody species and a rate of growth beyond anything European, the crying necessity for finding out something definite about them seems beyond the region of argument.

8. It seems as well to be clear about what the aims of any method of working should be :—

(i) We wish to increase the proportion of teak and certain other trees, but not to cause the disappearance or suppression of any species now present.

(ii) We wish to avoid forming large pure forests of teak.

(iii) We prefer natural to artificial regeneration.

(iv) The soil is to be exposed as little as possible.

(v) Tending to be reduced as much as possible in view of the large areas we have to deal with.

(vi) As bamboos, weeds, and most trees grow very quickly in Burma, the European, and for temperate climates usually accepted, rules about the advantages of growing any crop pure and dense in early youth do not apply. We get our soil covered, our stems cleaned, and our boles cylindrical without any special intervention on our part.

(vii) Teak is a light demander, slower in growth than bamboos and many softwoods ; any form of natural regeneration must imply a great deal of tending in early youth and possibly artificial restocking.

(viii) For facility of control in regeneration, tending, and extraction, approximately even-aged blocks of forest appear desirable.

9. One thing seems certain ; we must make up our minds to a great deal more forestal work in tending the regenerated crop than has been admitted as possible hitherto. And this means more decentralisation, more power in the hands of the man on the spot.

10. As to the method of regeneration to be adopted, we are still too ignorant to be able to lay down the law. The selection system must be ruled out, because it does not result in an even-aged crop. I incline to think that we shall have to rely on a clear felling when the seed-year has been good, combined perhaps with regeneration from adjoining woods. The object of leaving teak standards, as mother-trees of beech or oak are left in Europe,

seems to me with our tropical rate of growth and absence of climatic dangers like frost and snow unnecessary. Insolation is a danger greater here than in Europe, but the season of germination is not immediately followed by the hottest time of the year as in Europe. Moreover, for teak the less shade the better. The damage done by exposing the soil must be risked. Clear-felling would include removal of bamboos and all cover as if for a "taungya," and would probably imply the use of fire. In connection with clear-felling I would invite a reference to the Burma Annual Report for 1907-08, pages 54, 55, and 77, where the spontaneous appearance of teak on a bare area is commented upon. A patch under regeneration would have to be limited to a workable area. Anything like our present "sub-periodic blocks" of 30 or 40 square miles is out of the question: 100 acres is a maximum limit for each patch to be intensely treated with a view to regeneration resulting in an even-aged mixed crop with teak predominating—and the number of years within which the crop must be completed should be fixed. As in Europe, if the proportion of teak springing up naturally is not enough, resource must be had to a nursery. And in the present condition of our forests, much as I am by training and experience against plantations, the presence of a few artificially formed even-aged woods—not of pure teak, but invariably mixed—dotted about the forest according to a previously arranged scheme and distributed to suit the lines of management, not only to suit the ideas of local villagers, would help very much by forming centres whence work might radiate. Much might be done at the time of regeneration to encourage certain species, congeners of teak known to produce timber of high technical utility, like *Lagerstrœmia*, *Xylia*, *Gmelina*, *Nauclea*; a list of such trees to receive special encouragement against bamboos and weeds, not against timber trees, should be prepared for each forest. The encouragement should take the form of artificial regeneration in addition to protection of saplings.

11. These appear to be the lines upon which some system of regeneration will ultimately be developed—probably for some time a combination of clear-felling with natural and artificial

restocking, really the group system with rather large cleared patches. But our staff is not yet big enough even for the moderate degree of intensive working outlined above, and it is difficult to justify clear-felling when it must entail the sacrifice of much vigorous young stock. For the present one must take steps to lead the present stock over into a series of age-classes which will render the clearance of a large proportion of immature trees avoidable. In a forest of 120 square miles some attempt should be made to remove all the timber, both of teak and other species, which will pay for its fall over, say 20 square miles, so that the total operation is conducted at no loss, with the object of leaving a youngish crop where no tree has a girth of more than 3 feet; at the same time thorough tending must be instituted over the area to succour any valuable species in danger of suppression, and must be continued for 25 years or so till all saplings are established. Wholesale bamboo felling would also be necessary. The use of fire might form a basis for experiment over part of the area. It should be understood that these operations are to be conducted not with the object of inducing natural regeneration, but to force up every tree now on the ground less than 3 feet in girth; it is thought that there will be at least enough suppressed trees of this class to replace those over 3 feet in girth which are felled. This block would then be available for beginning regeneration by patch clear-felling perhaps with artificial aid after another 80 years, and there should be no need then for any fear of removing too large a proportion of immature stock. After the first 20 years a second block would be taken in hand.

This method would produce something like a uniform series of age-classes and would cause no great sacrifice either directly or by loss of increment. It agrees with the principle of concentration upon definite blocks, a desideratum which Mr. Troup has wisely emphasised, with the principle of working by area instead of by volume, and with the principle of combining operations to induce the formation of even-aged crops with removal of mature timber and intensive tending of the crop now on the ground.

The absolute regeneration of a definite block as practised in Europe, where a definite area can be stated to be "under regeneration," must wait until we have something like an even-aged forest to deal with.

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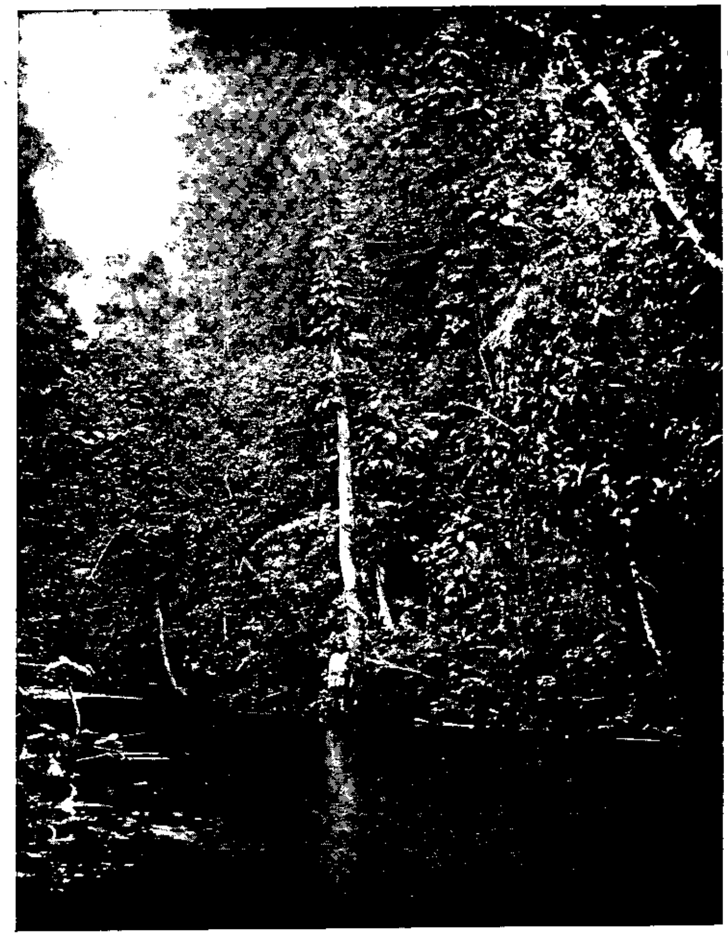
FIRE CONSERVANCY IN INDIAN FORESTS

FIRE CONSERVANCY IN INDIAN FORESTS.

For a long while fire conservancy has been regarded as of utmost importance for the maintenance of the forests in India, but a question is steadily coming forward as to whether fire conservancy is always beneficial. Many articles have already appeared in the pages of the *Indian Forester* with regard to the teak forests of Burma and Sal forests of different places. Regarding the teak forests the forest administration reports of Burma for recent years give very disappointing reports. Messrs. Troup, Slade, Walker and others expressed unfavourable opinions regarding the results of fire-protection for long periods in teak forests. Mr. Beadon-Bryant, then Chief Conservator of Burma, dealt with the subject fully in an article in the *Indian Forester* for December 1907, in which he writes: " A perusal of the remarks made in the forest administration reports of late years on the subject of natural reproduction in teak forests will show, however, that a continuance of the present policy of fire-protection with the selection method of treatment will lead to the extermination of natural grown teak over very large areas of our most valuable teak-producing forests." Mr. Barrington Moore writes in the *Indian Forester* for May 1909: " On the same type in unreserved (unclassed) forest *not protected from fire* there was a large proportion of teak, often being found in pure groups, with excellent reproduction." The same contributor writes regarding the Sal forests of Assam: " The excessive moisture in Assam creates a problem which, until it is satisfactorily solved, does far more damage than the frost. It causes such a luxuriant undergrowth of small tree species, shrubs and creepers to come up under the Sal, that in a forest which has been protected from fire for a number of years, the future regeneration of

Photo. Mechl. Dept. Thomason College, Roorkee.

(i). Sal seedlings in dense undergrowth of ferns.



Photos.-by B. Sen Gupta.

(ii). Sal tree growing on the edge of water.

FIRE CONSERVANCY IN INDIAN FORESTS.

(i). *Sal seedlings under dense shade of Macaranga denticulata.*

Photo. Mechl. Dept. Thomason College, Roorkee. Photos. by B. Sen Gupta.

(ii). *Dead sal seedlings.*

FIRE CONSERVANCY IN INDIAN FORESTS.

Sal is virtually impossible." Also, "Any one who considers the use of fire as a breach of the laws of sylviculture need only see the excellent condition of a forest continually burnt and then protected for one year (Khariarbandar Forest, * in the Jalpaiguri Division, which has been only recently reserved), where you find all ages represented by different groups of Sal with practically no admixture of inferior species, and no creepers, and remarkably thick patches of reproduction wherever you have an opening." Indeed, lots of such quotations could be made to show the doubt which exists regarding the benefit of fire-protection. Nobody, of course, thereby condemns fire-protection altogether, but the question is whether, if it is continued too long, a certain amount of harm does not result.

Most of the forests of India were subject to annual fires, unchecked grazing and reckless fellings for many years before the Forest Department was started, and consequently the soil was quite impoverished. In order to prevent further deterioration fire-protection had to be scrupulously undertaken, while excessive unregulated fellings had to be stopped. After successful fire-protection for so many years, the open areas are being very quickly filled up with tree species, the soil too has been restored to its proper condition for tree-growth, yet natural reproduction of Sal is not at all satisfactory; on the other hand, it is far worse than that at the time when the areas were unprotected and were subject to several kinds of damage. Even now we see that natural reproduction is far better in unprotected areas where nearly all classes are represented (*vide* Mr. Barrington Moore's remark regarding the Khariarbandar forests quoted above). In an area protected for a long period all the stages from pole (and sometimes from sapling) to over-mature are present, but the seedling stage is nearly absent, which shows that before fire-protection also all the stages were present though the growing stock was deficient on account of reckless fellings. The trees of those days are the present old, cragged, over-mature ones, the poles, saplings and seedlings are the present mature trees and poles. Now comes the question whether

* *Vide* Plate 10 in Vol. XXXV of the *Indian Forester*.

fire-protection is still to be continued as scrupulously as before. But before we take up the question, we must consider the cause of the absence of natural reproduction which is generally supposed to be due to the direct effect of fire-protection. It is recognised without any doubt that in some parts of India at least natural reproduction is not proportional to the old crop in areas protected for a long period. Several causes have been suggested to account for this absence of natural regeneration, *viz.*, excessive luxuriant growth, excessive moisture, want of sufficient light, want of soluble salts, deterioration of the soil, frost.

Excessive luxuriant growth may hinder natural regeneration either by directly covering the ground surface and thus keeping the seeds from reaching the soil and thus preventing germination, or by suppressing the seedlings after germination.

Luxuriant undergrowth may stand in the way of natural regeneration directly in some species only ; as, for example, Sissoo in which the pods are indehiscent and consequently the seeds cannot reach the soil easily, or *Oroxylum indicum*, or *Bombax malabaricum*, in which the seeds are rendered exceedingly light by the presence of the appendages around them. But heavy seeds, *e.g.*, teak, are not easily prevented in this way from reaching the ground. In some cases, however, where the undergrowth consists of very thick herbaceous plants the seeds may be held up temporarily and as the old leaves of the herbs rot the seeds gradually sink till they reach the ground surface. Sal seeds, on the other hand, mostly germinate as soon as they are shed even though they may not reach the soil ; in doing so, they send down the long radical first and then develop the plumule. The embryo plant lives for some time on the reserved food material stored in the seed itself ; meanwhile the leaves of the herbaceous plants become weaker, and the embryo plant heavier, until at last the herbs can support it no longer. The radical then easily enters the soil. Plate 5 (*i*) which was taken after clearing the ferns in order to show the seedlings, shows that even the thick growth of ferns (which may be called the thickest possible undergrowth as regards the hindering of natural reproduction) could not prevent the regeneration of Sal

from seed. Small pegs were placed in order to indicate the seedlings in the thick undergrowth more clearly.

Regarding the suppression of the seedlings after germination, we should bear in mind that most of the species can bear shade at the very young stage, and some species are good shade-bearers; still in most cases we do not get all the stages under the parent trees in a pure crop. Teak remains leafless for some time in the year, and thus admits sufficient light to the young seedlings, yet we hear the complaint that natural reproduction is not at all satisfactory under the parent trees. On the other hand, we find that in the same locality, though natural regeneration is wanting under the parent trees of less density, it is quite satisfactory under *the shade of other species of more density.* Plate 6 (*i*) shows a good example of this, in which case we see that Sal is growing quite well under the thick shade of *Macaranga denticulata,* but it is rather curious that not a single seedling of *Macaranga* is found there, though the trees seed profusely every year. A screen had to be used to show the small seedlings more clearly in the photo. The kind of forest in which this photo was taken is depicted in Plate 13 in the number of *Indian Forester* for May 1908, Vol. XXXIV.

Excessive moisture.—If protection for a long period caused so much moisture in the ground as to hinder natural reproduction, it would do so in all the parts of the forest under close cover, and not in particular parts of the forest only: but though we do not find many seedlings under the parent trees, they may be found abundantly under other species close by. Plate 6 (*i*), as already stated, shows good natural regeneration of Sal under *Macaranga denticulata,* but not a single seedling of *Macaranga* is found in the area. *Macaranga* grows both in drier and moister soil than this, but refuses to do it in similar moist soil. Plate 5 (*ii*) is an example to show that Sal grows even at the very edge of water; it should be noticed that the tap root of the tree is actually in water. Sal has been seen to grow gregariously in places where water remains stagnant for some months in the year.

Want of sufficient light.—This comes to the same thing as the question of suppression which has already been dealt with.

Want of soluble salts.—It may be, that though the soil in a forest protected from fire for a long period may be rich in all the materials which are necessary for tree-growth, they are in an insoluble state, and consequently unfit for the use of the plants and must be decomposed before they can be utilised by them. This may be the chief cause of the unsatisfactory natural regeneration in a forest protected from fire for a long period.

Deterioration of the soil.—In the ordinary sense deterioration of the soil means the exhaustion of the soil so as to deter the growth of plants, *i.e.*, the plants have already absorbed all the food material available for their growth and nothing is left for the nutriment of young plants. But, for the formation of wood proper, the trees take no less than 50 per cent of the substance (carbon) from the atmosphere, and about 48 per cent (hydrogen and oxygen) from the water in the soil, and the remaining 2 per cent only (nitrogen and ash) directly from the soil. There is usually a sufficient quantity of water in the soil of all forests which have been protected for long periods and much of the ash taken up by the plants is returned again every year with the shedding of the leaves, flowers, and fruits which are very rich in potash. In an unprotected area the plants take the same quantity of food materials from the soil, but they return nothing; for the fallen leaves and flowers are destroyed by the annual fires, leaving only ashes which are a very poor substitute for the substance destroyed. Protection from fire for long periods, therefore, cannot exhaust the soil of its fertility more than fires do in an unprotected area. It is, however, admitted without dispute that the soil after many years' protection is enriched rather than impoverished.

Frost.—This is not a common cause, as all localities are not subject to frost, and all species are not susceptible to it, besides in a protected area the seedlings are better protected than those in an unprotected area.

Each of the causes mentioned above may partly hinder natural regeneration of some particular species in some particular locality, and the combined action of more than one may be more powerful; but leaving all these questions, how is it that the areas which are

subject to annual recurring fires are more blessed with natural regeneration? It seems that there must be some other agency at work. If there is any truth in the new theory that 'plants like animals, excrete a toxic substance which is highly poisonous to the plants of the same species, but not necessarily so to those of other species, and that it is easily changed, easily broken down, easily destroyed, and easily absorbed by the soil," this toxic substance is surely responsible for this absence of natural regeneration in forests which have been protected from fire for long periods.

In such a forest the soil has, according to the new theory, become so much poisoned by the toxic substance emitted by the plants that further growth of young plants of the same species is impossible. The seedlings after germination exist for a time on the food material stored in the seeds themselves, and scarcely take anything from the soil; but the reserved material cannot maintain the seedlings very long, so they seek their food from the soil and with their food they also absorb a portion of the toxic substance which is dissolved in it. Hence we may conclude that in a pure forest protected for a long period the seedlings must begin to die shortly after germination, and if the ground is not sloping, or if the soil is not well-drained so that the toxic substance is not partly at least carried off with rain-water in which it is easily dissolved, very few will survive after a year. Sal, which was the species I specially took for my observation, germinates in June-July, and in areas where the ground is fairly level, must die in August to October contrary to the general belief that they do so in winter. (The annual dying back of Sal seedlings which send up more vigorous shoots in the succeeding year is quite a different problem, and is not here referred to.) So I began to observe as to which is the particular time when the seedlings of Sal disappear, and found that *about* 50 *per cent of them died in the period between the middle of August to the middle of September; about* 30 *per cent from the middle of September to that of October* and the rest die gradually only about one or 2 per cent surviving at the end. It is very peculiar that they die very suddenly without showing any

sign of disease. No change of colour takes place before death, the leaves remaining quite green. The change of colour, after death, takes place just in the same manner as it does in the leaves of the fresh-cut branch of a tree, *i.e.*, it changes from green to brown (colour of dry leaves) without being yellow first. In some cases, however, when the seedlings struggle for some months, *i.e.*, those which die at the end of October, the colour slightly changes from dark-green to pale or yellowish green probably because deep shade also had some action on them in addition to the action of the toxic substance. If they had died for want of light only, they would have changed colour before death. The roots, too, are in quite good condition, so insects are not the cause. So, it appears that nothing but the toxic substance can be held responsible.

Now to return to the question of fire-protection. This important question has been frequently raised and the injurious effects of fires are known to all, yet the problem is unsolved. The solution would, it seems, have been easier if we classify the effects under two heads, *viz.*, the effect of fire on the plant itself, and the effect on the soil.

Effect of fire on the plant itself.—Fire injures a living plant by drying up the bark and leaves. Heat expands the cell-sap, and when it is excessive it turns it into vapour which bursts through the cell-wall; sometimes the combined action on a number of cells disconnects the bark from the wood and the vapour escapes by bursting open the bark with a loud report. Transpiration of water vapour by the leaves is also accelerated unduly, and there is not sufficient water to take the place of the quantity lost, thus the leaves dry up at once. Trees thus damaged often die or at least the growth is retarded for some time. If the fire is very furious, the bark and then the wood itself is burnt outright. The extent of the damage by fire depends on the susceptibility of the species to it. Species with thick corky bark, which is a good non-conductor of heat, will not be much affected, and those with succulent bark will also be less affected, as it will take some time to heat the water; again, those with thick cambium may not be

affected to a greater extent than by having their growth retarded for a while, for such a species can form a new layer and thus heal up the injury. Seedlings, of course, of all species, are easily killed by any fire, and fire is always dangerous to them. But in some species the seedlings bear dormant buds at the junction between the root and stem (*e.g.*, Sal), they develope new shoots when they are burnt or even slightly weakened by the fire. In such cases the fire does comparatively little harm.

Effect of fire on the soil.—Fire burns the humus and dead leaves, and thus destroys part of the food material. The soil becomes dry and is rendered unsuitable for a seed-bed. But in a forest protected for a long period from fire this damage is more than compensated for in several ways, *viz.*,—

The first and the most important is that the fire oxidises the soil and thus destroys the toxic substance by burning it directly, or the toxin may be destroyed by the action of direct sunlight to which the soil is exposed for some time after the fire.

Secondly, the soil is ærated. The air and moisture in the soil expand by the heat and thus enlarge the interstices in the soil which, after the fire, remain filled with fresh air only. This airing is very beneficial for the tree-growth.

Thirdly, paradoxical though it may seem, very dry soil is moistened, and over-moist soil is dried by fire. In a dry soil the small quantity of moisture at the surface evaporates and the space is soon filled up by water vapour from below. The top soil is heated with the contact of fire, and the soil below is heated by the contact with the already heated surface-soil, and so also the water in the lower layer of soil in contact with the soil itself. The water in the lower layer of soil thus heated and evaporated must naturally go up and pass through the surface-soil. After the fire is put out, the surface-soil cools more quickly than the soil beneath by the contact with air, and thus the water vapour which was passing through the top soil is condensed, and is retained in the soil which thus remains moistened after the fire. Similarly the over-moist soil becomes drier. In the forest which has been protected for a long time, the dry fallen leaves form a thick mass which practically

prevents the evaporation of water in the soil and thus render the soil too moist for the proper growth of seedlings. Fire burns the thick mass and exposes the soil to the action of air. The moisture in the soil evaporates, and by capillary action and the action of heat the water in the soil below rises up and evaporates in the same manner. This process continues, and there remains a regular flow of water like in a well-drained soil. Thus in one we get the effect of good drainage, æration, and also moistening.

The condition of a forest which was subject to fires and reckless hackings and then has been protected, becomes this :—

(*a*) *In a deciduous forest:*

1st stage.—Just after the protection is commenced, a large number of coppice shoots spring up from the stumps of the trees which were cut down before protection was started, and also from the stumps of the seedlings which were burnt back annually, innumerable new seedlings come up, also creepers and herbaceous plants and some brushwood.

2nd stage.—The soil is more moist than before, creepers, herbaceous growth and brushwood struggle vigorously with the tree species and reproduction from seed is less common.

3rd stage.—Trees, poles and saplings, with lots of woody creepers and brushwood, completely cover the soil, direct sunlight cannot reach the soil except for a month or two, the soil is very moist except for a few months in the year, natural regeneration is scarce and the seedlings which come up disappear mostly before the end of the year.

(*b*) *In an evergreen forest:*—The state is the same, except that the third stage comes more quickly than that in the former, and the soil which scarcely gets direct sunlight remains more moist and sour throughout the year, and there is still less natural regeneration from seed.

The condition of a private unreserved forest which is always subjected to fires and reckless hackings, is the same throughout as that of a state forest before protection. Natural regeneration is excellent, seedlings are burnt back annually, and new more vigorous shoots come up after the fire, vigorous coppice shoots are found all over the area, and creepers are nearly absent.

We are jealous of the excellent natural regeneration in the areas outside our reserves and jump to the concluson, that fires are generally beneficial without taking the trouble to see how they become so. Fire is certainly always injurious to the plant itself for though it may not, in many cases, kill the tree outright, the growth is retarded for some time, fungus enters through the burnt portion and entirely spoils the wood, dry trees and logs are burnt to ashes or rendered unserviceable, seedlings and saplings are killed, seeds, except in some cases, are completely destroyed, and so on, but in an area protected for a long period it does, to some extent, improve the soil. Protection for a long period causes the soil to deteriorate on account of the accumulation of toxin. In an unprotected area the soil is not affected by this poison on account of its having been destroyed by the action of fire, light and air as mentioned above; hence we find good natural regeneration there. In a forest protected for a long period the seedlings also come up just in the same proportion as in an unprotected area, but they are soon killed by the toxin. Plate 6 (*ii*), which was taken at the end of September, shows that most of the seedlings of the year had died already, only the stems being left, some had died recently, the leaves still persisting, and only one was found surviving. (A screen had to be used to show the small seedlings more clearly.)

Fire, as is well known, is a bad master, but a good servant. If we keep it under our control and use it in combination with the fellings as a subsidiary operation, results will be most satisfactory. After a felling the soil is exposed for a while to direct sunlight and air, so the toxic substance is partly destroyed and large number of seedlings will survive till October without any difficulty. In October, after the cloudy and rainy days of the wet season are over, the soil again gets clear light and heat, and the seedlings

show vigour for a short period. Winter is the period of vegetative rest. In the spring the seedlings will be invigorated again, but as the seedlings grow on, they have to send their roots deeper down to where the toxic substance is still present (for, by the short exposure, the poison in top-soil only was destroyed and that underneath remained the same as before). So after a time, how long depends on how long the seedlings take to send down the roots to the poisoned soil, they die. After a felling, not only do the felled trees cease to emit the poison, but, theoretically, their removal causes less check in the underground flow of water than before, because many of the lateral roots soon decay. Thus, owing to the increased flow of water during the rains, part of the toxic substance is carried off. (Probably this may account for the better growth of Sal and teak on high lands. The poison is washed off from the high well-drained soil and deposited in the low land where the soil is less drained.) On fairly level ground there is less drainage, consequently the toxin, though dissolved in water, remains in the soil, but is more evenly distributed than before. So in a few years after the felling natural reproduction will gradually cease and the forest will be in the same state as regards regeneration as before the felling. Big trees, however, while emitting the toxin send down their roots till they reach the place where they get a permanent water-supply; at this stage further growth of the roots is practically stopped. Here they get a slow regular flow of water through the soil throughout the year, and part of the toxin too is removed as it is emitted. But a time comes when the roots of the second class trees overtake those of the first class trees which remain practically stationary. At this stage the soil gets more toxin than the water can drain off; consequently, it is poisoned more and more. The older trees which are now over-mature and the mature ones, if left, succumb one by one. In the fellings we generally remove all the over-mature and mature trees, and by the time the third class trees become first class and send their roots down to the permanent water-supply, nearly all the poison in the soil has disappeared, so they live for some time without any difficulty. The fourth class trees which were then saplings and seedlings had to

take their food mixed up with very high proportion of the poison, there being no flow of water near the surface except during the rains, consequently they cannot survive very long. Hence we practically get no natural regeneration under the parent trees.

In all the forests where natural reproduction is scanty on account of protection from fire for a long period, it would probably be best to expose the soil at intervals. To do this firing will have the double effect of getting rid of the poison by burning it directly, and also by admitting light and air as has already been explained. In the Khariarbandar forest, in Jalpaiguri Division, which Mr. Barrington Moore cited as an example to show the excellent reproduction of Sal in a forest continually burned and then protected for a year, the healthy condition of the seedlings under the parent trees, where fires have caused the destruction of the toxic substance, can be seen by referring to Plate 10 in the number of the *Indian Forester* for April 1909, Vol. XXXV. If the areas are burnt at intervals of, say every five years after the felling, very good results may be obtained. But fire does great deal of harm too. Our aim is to exterminate the poison, if we can do it without making the forest subject to other injuries, that would be the best policy. We can expose the soil by cutting back the creepers and the undergrowth, but as this has a much less effect than firing, this operation may be done at intervals for two successive years if one year's work does not give good results. But fire, if it can be properly managed, will probably give better results. We may reduce the bad effects of fire to a minimum by keeping it under our control. This can easily be done by burning the areas at a different time of the year according to the climate and locality. In the moist climate of Eastern Bengal and Assam we may safely burn even in so late as February, while in the dry forests of the Punjab it cannot probably be postponed further than December, and so on.

The subject is a very important one, and the problem is a difficult one. It may take centuries to solve, but anything that may tend towards the solution of the problem should be carefully kept on record in the Research Institute, and forest officers from

different parts should carefully note whatever may help in the solution. My experience is limited to a few localities only; officers from all the parts of India should carefully make experiments and note down the results. Observations are required on the following points:—

(1) Whether opening out the areas as mentioned above improves the natural reproduction.

(2) Whether opening the areas at certain intervals can produce the same results as by burning.

(3) Whether burning gives better results than the ordinary way of opening by cleaning the creepers and undergrowth.

(4) How long after germination the seedlings disappear, if the seeds germinate at all under the parent trees in forests, protected from fire for a long period?

(5) In a forest protected for a long time where natural regeneration is wanting, whether there is any difference in the composition of the soil from that in an unprotected area where natural reproduction is excellent. The soil should be examined chemically, samples of soil sent by parcel from different parts, will not do; for, as the new theory goes, the toxic substance is rapidly destroyed by the action of light or air. Samples sent by parcel will probably lose part at least of the toxin. The chemical examiner should go to the spot himself and examine the soil then and there, and if possible, the examination should be carried out in an air-tight vessel. The soil should be also examined before and after a fire.

(6) Dr. J. C. Bose, who made a series of experiments on the effects of poison on plants, may be requested to examine on the spot some of dying seedlings in a forest protected for a long time and some healthy ones in an area outside the reserve where natural reproduction is most satisfactory, and find out if there is any effect of poison of any kind on the

dying seedlings, and if so, what the kind of poison is.

(7) Since the toxic substance emitted by the plant is not necessarily poisonous to other species, it is natural that all the forests have a tendency, like the fir forests of the North-West Himalayas, to change from pure to mixed crop. Special record of detailed description of forests of pure crop should be kept in all local divisional forest offices, and this should be compared with the crop on the ground every 20 or 25 years, to see if there has been any change in the distribution of the crop.

(8) Distribution of crop in all plantations should be noted at intervals of every 20 or 25 years.

Etc., etc.

I know many will comment on the over-presumptuousness of my writing on the subject that "Fools rush in where angels fear to tread"; but I frankly admit that there is not much originality in the article which is based on bare facts and opinions expressed by the highest authorities.

B. SEN GUPTA,
Forest Ranger,
Jalpaiguri Division.

25th October 1909.

SOME NOTES ON THE RAJAHMANDRI TIMBER MARKET FROM A CENTRAL PROVINCES POINT OF VIEW.

The chief market for timber from Western Bastar, South Chanda and the Eastern Jagirdars of Hyderabad lies down the Godavari, Rajahmandri, on the E. C. Railway, in the Godavari District of Madras, being the centre to which the produce is exported wholesale, to be retailed by merchants, who have possibly never been near a forest in their lives, but who finance on exorbitant terms petty contractors destined to get but a little of the profit on the timber they actually exploit.

There are large timber yards along the bank of the Godavari, the annual trade being estimated at ten lakhs of rupees. The

notes below were made during the rains of 1908 when I visited Rajahmandri.

The stocks were mainly teak up to 3 feet in girth. Unless a log was large and fairly sound it was sold as a piece at from Rs. 10 to Rs. 25 and not by the cubic feet. There seemed to be no fixed standard of size ; but if a log would cut up into planks profitably, it was sold roughly squared at Rs. 2 to Rs. 2-4 a cubic foot. The better class logs were second class Burma teak which sold at Rs. 2-8 per cubic foot of log. It was straighter grown and larger than the Central Provinces and Bastar stuff, but did not possess the same dark colour and is said to be not so easy to work.

Bija and Saj (*Pterocarpus Marsupium* and *Terminalia tomentosa*) were stocked chiefly in 2 feet and 2½ feet sizes, about 20 feet long. Length is an essential. Contractors in the forest do not like to buy large logs of these species owing to the difficulty in floating, which probably accounts for the larger girth class being very poorly represented. There is a great demand for these species for house-building.

Haldu (*Adina cordifolia*) is not seen in any quantity, but is valued about the same as Bija and Saj. Albizzias are not used or known. Anjan (*Hardwickia binata*) has to be carted, as it is too heavy to float, and hence only purely local timber was in stock and not very much of it. It is highly valued for posts, as it is almost immune from the attacks of termites.

Shisham (*Dalbergia latifolia*) appears only in very small quantity and sells at the same rate as Bija or Saj, whereas in the Central Provinces it is a first class furniture wood fetching a higher price than teak.

Lendia (*Lagerstrœmia parviflora*) sells very well, chiefly in the 1½ feet to 2 feet class, and is apparently growing in popularity owing to the high price of teak poles.

Odina Wodier and *Bombax malabaricum* were said to have a small sale at Coconada ; but I do not think they have ever been sent from the Central Provinces.

Acacia Sundra, D. C., 15ins. to 18ins. in girth, is in great demand for grain-pounders, etc., and such pieces are worth over a rupee

each. I fancy that Khair (*Acacia Catechu*, Willd.,) would serve the purpose as well. It grows to a large size in our forests and the two are very nearly allied if not indeed the same species. Any way, this is a line that is absolutely untouched by us so far. The difficulty is again its weight, for *Acacia Sundra* weighs about 70 lbs. and *Acacia Catechu* about 60 lbs. per cubic foot.

The ordinary bamboo (*Dendrocalamus*) sells at Rs. 40 per mille, and if it could be floated quick enough to prevent its rotting would be a very profitable line, as it could be put on the Pranhita river bank at Rs. 20 to Rs. 25 per mille, and would serve to buoy timbers heavier than water.

There seems to be a great opening in Rajahmandri for an up-to-date saw-mill, combined with the powellising process and match factory, with possibly a wood-pulp concern as well. There is no lack of produce ; but the advent of a railway up the Godavari valley might somewhat alter the conditions. At present contractors take two years to float their rafts down the 200 miles of river that lie between the Central Provinces and Rajahmandri. The river is bad from a floating point of view and the men worse.

This year there were rumours that the market was overloaded, that large consignments had come from Burma and that a recent big Central Provinces contract for unusually large as well as cheap teak timber had rendered the poorer qualities unsaleable. Whatever be the cause, not one stick of timber was sold down stream in the annual December auctions this year, and in this district alone about a lakh of rupees worth of teak has been held up in consequence.

Can any Madras officer give the true explanation of the unwonted shyness of the Rajahmandri dealers? For the last five or six years they have bought everything that was offered them and paid good prices for it.

It would also be of considerable help if the *export* rate of 2nd quality Rangoon teak could be given along with a rough estimate of loading and unloading charges and the freight from Rangoon to Calcutta or Madras for large quantities of timber.

There is much information of this sort which might be of great value in finding markets for our various species of trees; but which is very difficult for a divisional forest officer to obtain for himself. There seems to be considerable scope for a few commercial notes on the internal timber trade of India which might include lists of the ruling rates for forest products in different centres and the names of the principal dealers and contractors.

Where there are plenty of contractors, and the demand in the forest is keen, the matter may not be of great importance; but where there are thousands of tons of valuable timber rotting in our forests, enterprising contractors non-existent and the local demand *nil*, published notes or pamphlets on the timber trade in the open country would be of great value in opening the backward areas and in the sale of what the babu persists in calling our "other kind trees."

J. DONALD,
Indian Forest Service.

CHANDA, C. P.

SHIKAR, TRAVEL, AND NATURAL HISTORY NOTES.

MEAT-EATING ELEPHANTS.

Having always been under the impression that elephants were entirely herbivorous, I have been much astonished to hear of a private elephant owner in Malabar who feeds his elephants on mutton and chickens. The elephants in question are employed on heavy timber work in hilly country and the owner reports that they are very seldom sick; for four months in the hot weather they do no work and are fed on mutton and chickens. Each elephant gets from 30 to 40 chickens a month, minced up raw, and about two sheep in the four months, given fried. This treatment is said to give them back all the strength expended in the working season and to keep them in excellent condition.

Is this unique, or does a similar practice obtain anywhere else in India or Burma?

F. A. L.

DAMAGE TO FOREST TREES BY BLACK HIMALAYAN BEAR.

In Kashmir the black bear are the worst offenders in doing damage to deodar and blue pine trees. As a general rule, the former suffer more. The damage is universal over about 2,000 square miles of forest. Figures, however, only exist for one forest division which includes, roughly, 200 square miles of first class deodar and blue pine forest. During complete enumerations for working-plans it was found that no less than 25 per cent. of the saplings and middle-sized poles had been damaged, and it is most probable that fully 50 per cent. of these have been killed and the other half sufficiently damaged to prevent proper growth and to allow spores of fungi to enter.

The damage is done by the bear removing, with their teeth and claws, the bark, which is quite fresh and thin, for about 3-4

feet from ground level. In many cases such trees are completely girdled.

It is not known for certain why the bear do this ; but as such damage is nearly always done in the spring when the sap is rising and when the bears are weak and hungry after their winter period of hibernation, the reason is either that they eat the cambium as a medicine, which idea the natives favour, or because they are hungry and have not the strength to kill cattle, and also as there is no fruit at this time of the year for them to eat. Bears are generally vegetarians, but when hard-pressed for such food they are not adverse to tackling cattle, and what they really enjoy is a nice succulent hump off a bull or bullock, but will also kill cows and calves. I have often seen bulls or bullocks with their humps removed by bear with their shoulder-blades showing.

A curious result of the damage by bear to deodar is that the Mochis or leather-curers who used to utilize deodar bark for tanning are now beginning to imitate the bear and use iron 3-clawed instruments to make marks on cambium after having removed the outer bark. This ingenious device has only come into vogue during the last few years since removal of bark from green deodar has been put a stop to.

It is easy, however, to tell who are the culprits ; namely, the bear or the Mochis, as the former leave the outer bark on the ground, whereas the latter remove it for tanning leather.

G. RADCLIFFE.

TIGER SHOOTING IN THE BERARS.

I was camped on the north bank of the Pengunga, in the Berars, in a beautiful large mango "tope" or grove. It was the hot weather, and the time was drawing on for a return to head-quarters and to civilisation. I had been away in the jungles for nearly six months, and was getting rather tired of my own company, so it may well be understood how pleased I was, on riding back to my tents one morning after finishing my work, to see another small camp pitched a little distance away from my own. I inquired

whose it was, and was informed that Capt. L. from Hingoli had come out to try and get some sport. I at once made my way over to his tent and introduced myself. We speedily made friends and L. came over to breakfast with me. Pimpri, the name of the village where we were camped, was in black soil country, a paradise for black buck, the Indian antelope. The plain country, however, was only a strip some four to five miles wide along the course of the Pengunga River; beyond this was hilly country, clothed with heavy forest, principally teak. L. told me he had come out on ten days' leave to see what he could pick up. He had not come without a certain amount of foreknowledge, for his shikari, Karim, was acquainted with the district and had promised him good sport. I was in a position to corroborate Karim's testimony; there were many black buck in the open, while in the hills there were bears, sambhur, chinkara, etc., and tigers had been making their presence felt among the surrounding villages. I had had a fair amount of sport myself, but so far had not come across any tigers during my stay. We very soon called Karim and my own shikari into our conference, and finally decided to tie up half a dozen helas (*i.e.*, buffalo calves) in various likely spots.

A couple of days passed uneventually. L. shot several black buck while I was engaged in my ordinary duties; but early on the morning of the third day news was brought in of a kill about four miles distant from our camp. I at once postponed my morning's work, and L. and I were very soon off to the scene of operations. The kill had been perpetrated in a wide sandy nullah running up from the Pengunga, some hundred yards or so across at the actual spot. There were numerous tamarisk bushes in the bed of the nullah, and the sides were crowned and flanked by low brush jungle, "palas" (*Butea frondosa*) trees, and the like; but there were no trees of sufficient size to afford a seat for either of us, so we decided to take up our positions on the ground on the bank of the nullah, while the beaters were to make a round of about half a mile and come down towards us and the main river. L. got choice of position, and took the one furthest from the river. Just above where the kill had taken place the nullah forked in two directions, and

the trackers had located the branch up which the tiger had retreated after his meal and drink. L. was posted on the side of this branch some 150 yards up, while I took up my position just below the fork. The beat began, and in a short time I heard L. fire two shots, evidently right and left, and then presently I was aware of him sprinting down the course of the nullah, hatless and gunless, in my direction, with the tiger in full chase after him.

It was a most extraordinary sight. The tiger was dragging itself along on its hindquarters, not more than six or eight yards behind the flying man, and every now and then making yearning but futile attempts to strike him with one of its front paws. At first I could do nothing, for L. was directly between me and the angry beast, and I was unable to fire for fear of hitting my friend. As they passed the fork, however, the chase opened out, as it were, and I got a chance of a broadside shot, of which I took advantage, and was fortunate enough to make a good one, hitting the tiger behind the shoulder and rolling it over, much to L.'s relief. He told me the beast came out to him, but saw him immediately it had cleared the tamarisk bushes in which it had been lying up, and he had to take his shot at once. Being up on the bank he was above the tiger, and fired at its head, which he missed. The shot, however, took effect in the hindquarters and broke the brute's spine, thus fortunately for L., paralysing it to a partial extent. L.'s second shot missed, and when he turned for his spare gun he found his man had fled, taking the weapon with him. Seeing L., the tiger made for him, and he had to take to his heels, which he did, running in my direction, with the result described. L. was fairly blown, very hot and very angry, but not in any way hurt, though I would not have given much for his chance of life if the tiger had been able to reach him. The animal was a very fine one, and measured between the pegs, 9ft. 2in. When L. went back to Hingoli at the expiration of his leave, Karim remained with me, and stayed for several seasons. He was the best shikari I ever had or ever heard of. He was absolutely fearless, at least so far as tigers were concerned, and he was a marvellous tracker. His *modus operandi*, in country like that I have been describing, was

to follow the pugs from a kill, track the tiger down to its resting place, make sure by ringing that it had not gone further afield, and then, placing scouts on trees in the "neighbourhood to watch," he would bring in the khubber (news), and one was pretty sure to get a shot at any rate.—(*By D. F. O. in the Field.*)

GAME PRESERVATION IN INDIA.

India, as a land of sport, has been exploited for a hundred years, but little has been done to improve and develope what nature has created as a magnificent playground for the sportsman. Little, indeed, has been done even to protect the larger game from extermination. Seventy or eighty years ago, lions were found as near populous centres as the neighbourhood of Delhi. But, for a long time, the only lions left in a wild state in India have been a few near Junagadh, in Kathiawar. When it was discovered that the breed was all but extinct, care was taken before it was quite too late, to leave them unmolested, so that they might increase and multiply sufficiently, at any rate, to provide sport for some very specially honoured visitor. The Asiatic lion was considered too rare and precious even for the rifle of Lord Curzon, where, in the early days of his Viceroyalty, he was meditating shooting one in the forests of Gir. Quite recently (last year) when the Bombay Natural History Society required a specimen stuffed for their museum, there was much heart-burning regarding the selection of the lucky individual who was deputed to slay the king of beasts for the purpose.

The survival in greater numbers of tigers, leopards and other large game has often been due to accidental cases such as the abandonment of small military stations in remote parts as, recently, in Chota Nagpur, and in the Hyderabad State. Certain areas within their respective territories have been set aside by various Indian princes, as shooting grounds for themselves, and distinguished visitors, and thus many European royalties on tour in the East have been enabled to indulge in the rôle of Nimrod. In the Kashmir State, there is a Game Preservation Department, the rules of

which were initiated by Colonel Ward (who retired last year) and these have been perfected by Major Wigram. Under these no yak may be killed or caught, and no birds or wild animals netted (except hawks in one district only). The sale, or export for sale, of horns or skins is prohibited of brown bears, burhel (*Ovis nahura*), sharpu (*Ovis vignei*), goral, markhor, Ovis Ammon (*Hodgsoni*), ibex, Thibetan antelope, Thibetan gazelle, barking deer (*khakur*), serow, and Kashmir deer. Only under restrictions are the females of most of these animals permitted to be shot at all, and the licenses purchasable fix the number of the males that can be shot. Licenses place no limit to the number of pigs, leopards, and black bear that may be shot, and the sale of their skins is allowed. There are close seasons for the shooting of both birds and beasts. There are limitations to the areas in which shooting is permitted and, although no shooting at all can be had without a license, the destruction of wolves, lynxes, foxes and martens is encouraged.

In Southern India, as Major Glasfurd points out in his delightful work, *Rifle and Romance*, the destruction of large game has too often generated into slaughter for commercial purposes. Native *shikaris* have been paid to kill all sorts of wild beasts at so much per head, and the trophies have been sold at enormous profits. The purchasers have been by no means confined to persons interested in natural history, who wished to have good specimens, but also, as Major Glasfurd seems to suggest, include individuals who can spend money more easily than they can hit a moving target, and are unscrupulous enough to desire to pose as mighty hunters in the eyes of their confiding friends at Home.

The time is yet far distant when game in India will receive the same care and attention as in England.

A good deal has been done of late, however, to improve and stock fish in Ceylon and Kashmir and—more recently—in Kumaon also.

It is some years since, that, after much trouble and a certain amount of failure, Mr. Frank Mitchell introduced the ova of English brown trout into the valley of Kashmir with the assistance of the authorities of that State, and of the Duke of Bedford in

England. A hatchery was established at Harwan, nine miles from Srinagar, in a valley kept as a close preserve for stag shooting, as well as fishing, for the guests of the Maharaja. When Lord Minto visited Kashmir, a trout weighing as much as 12½lbs. was taken out of the stock ponds but, outside, none have been found so far more than 10lbs. The experiment has proved completely successful, and ova and yearling trout have been sent to other streams in Kashmir, as well as to certain mountain lakes. The prevalence of poaching, in spite of the requirements of fishing licenses, is the most formidable obstacle to the multiplication of the English trout. The fish will only take artificial flies put to them when the streams have ceased to be fed with melted snow, being apparently suspicious at times when the natural fly is not usually found on the water.

Lord Minto's visit and interest in this fish culture having drawn the attention of the Maharaja to the success of the experiments, His Highness ordered the importation of the ova of the Danube trout, or Huchen (Salmo Hucho), the largest as well as the most sporting of Salmonidæ. They are known to run to 26lbs., and at the Fly Fisher's Club in London a specimen is shown which weighed as much as 29lbs. They are sometimes called the Danube salmon. Some three or four years ago they were introduced into the Thames, but, I believe, up to the present, none have been caught. Early in 1908, the ova arrived in India, and—to show the great pains taken with regard to acclimatising them—it may be mentioned that Mr. Frank Mitchell himself went all the way from Kashmir to Calcutta to receive the consignment from the steamer in person. In the spring of 1908, 2,000 hatched out successfully in the Harwan hatcheries. When grown sufficiently big, they will be put in the rapids of the Jhelum river below Baramulla, just where it leaves the valley of Kashmir for the narrow gorge among the mountains through which it runs nearly one hundred miles before it reaches the plains of the Punjab. It is too soon to express an opinion as to the future of this importation. The latest reports, however, are that the fish are alive and show no signs of diminution in number.

The success of the English brown trout in Kashmir has led to the ova being sent to Kumaon, to extend this pisciculture to its lakes and streams. Sir John Hewett, the Lieutenant-Governor, has shown a keen interest in the project, and the Forest Department, it is understood, are taking up the work, with the advice and assistance of Colonel Ward whose knowledge and experience as a sportsman and naturalist are well known. Mr. Frank Mitchell has also been consulted, and he visited Kumaon in the autumn of last year for that purpose. Hatcheries have been started at a convenient spot between Naini Tal and the other lakes, and there is every reason to hope that this venture also will prove satisfactory, the ova having arrived safely from Kashmir. Many of the Kumaon lakes are believed to be on too low an elevation for English trout, but in the lake at Naini Tal, when the large marsiya (who would prey on the imported fish) have been destroyed by dynamite (as is proposed) it is believed the trout will do well.

It is interesting to add that at the recent Lahore Exhibition there was a small quantity of ova hatched for public inspection. It was intended to put these out in a small stream in the Salt Range in the Punjab, but by some accident, the young fish came to an untimely end at the critical moment of their lives before the transfer could be made. Nevertheless, it is understood that the scheme of stocking a stream or two on the higher parts of the Salt Range will not be abandoned.—(*Pioneer.*)

[We hope shortly to be able to publish an account of the experiment of introducing trout into Kumaon. In the meantime we are in a position to state that the destruction of the marsiya in the Naini Tal lake by means of dynamite is not contemplated.—HON. ED.]

BIG GAME SHOOTING ON THE GOLD COAST.

Mr. H. N. Thompson, Conservator of Forests, Southern Nigeria, who has recently made a tour of the forests of the Gold Coast for the Government with a view to giving advice as to their preservation, has made a report to the Colonial Office. In the course of this report he says: "Some steps should, I think, be taken to

limit the number of hunters who shoot on the plains. The small villages scattered about them are inhabited solely by professional hunters, outlaws, and the riff-raff of the country, who earn their living by shooting game and selling the flesh in the larger towns. . . . Whilst Europeans are obliged to take out licenses, and are (very properly) restricted as regards the shooting of certain species, no steps whatever have been taken to in any way limit the incessant slaughter carried on by the natives. What the few Europeans who care for big game shooting kill is a mere drop in the ocean compared with the annual slaughter by native hunters, yet the existing restrictions are placed only on the former. If the reason for enforcing game licenses at all in the case of Europeans is the preservation of the game in the country, some action might be taken to restrict the immense amount of damage done by the natives. As matters stand, game preservation here is an utter failure. The real offenders have not been touched by the legislation regulating this matter. The killing of cow-elephants and their young by the natives has not even been prohibited, and in fact, the game laws contain a clause that specifically exempts the natives from their application. The argument is often put forward that the slaughter of wild animals has been going on for generations, and that they are still as plentiful as ever. This statement, however, does not agree with the facts. The native hunters themselves admit that game is getting scarcer and scarcer every year, and that they have to go further afield to get it. In the older days when internecine warfare was practically the normal state of affairs, the hunters, who formed the bulk of the armies engaged, had but little time to devote to the chase of wild animals ; now, with peace assured, they have taken to it with renewed energy, and are quickly making their mark felt. I may remark that a large proportion of the trophies taken out of the country every year by Europeans has been either purchased from the native hunters or picked out from the hunters' 'heaps' of skulls found in some of the villages. Very few of them consist of *bonâ fide* trophies obtained from animals shot by the Europeans themselves. This fact is mentioned in order to remove the erroneous

impression that the Europeans are responsible for the annual slaughter of a large number of animals. Proper inquiries will, I think, confirm my assertion. Only those who have had real experience of big game shooting in tropical West Africa can realise the arduous nature of the undertaking involved in procuring anything like a large bag. Again, the number of Europeans out here who would walk a mile in full exposure to the sun to shoot a wild animal is extremely small. To sum up, it may be safely accepted that, with perhaps the exception of the hippopotamus, there is at present no danger of the large game of tropical West Africa being exterminated by the white man. The conditions out here are far too unfavourable for any but the greatest enthusiasts to take up in earnest big game shooting as a pastime. The real danger comes from the native inhabitants themselves. An alternative to limiting the number of native hunters allowed to shoot on the plains would be to take up a portion of the latter as a game reserve and to strictly prohibit all shooting within the area selected."—(*The Field.*)

NEW SHOOTING RULES.

KULU.—With the sanction of the Government of India, the Punjab Government has framed rules under the Indian Forest Act to regulate the shooting, snaring, etc., of game in Kulu. In future it will be necessary to obtain a license at a cost of Rs. 20 to shoot big game in the sub-division, and a limit is being imposed regarding the number of head of game which may be shot. Applications for licenses must be sent to the Divisional Forest Officer, and the licenses will remain in force for one year from the day of issue. Each year the Conservator of Forests will prepare a list of rakhs which will be closed to form sanctuaries for game. For a small game shooting a close season is prescribed extending from the 10th of March to the 1st of September, but this close period will not apply to geese and ducks. Snaring, trapping and netting of game, and the removal of eggs and nests of game birds, is prohibited, except with the permission of the Divisional Forest Officer.

KANGRA.—The new rules regarding the shooting of big game in the Kangra district provide that the holder of a license may not shoot more than the following numbers of the animals specified. —Ibex, 3 (no head to measure less than 33"); Nayang, 1 (minimum head 42"); burhel, 4 (minimum head 22"); Thibetan antelope, 2 (minimum head 22"); goral, 4 (minimum head 6"); tahr or kart, 2 (minimum head 17"); serow or yamu, 1 (minimum head 7"); barking deer or khakur, 3 (minimum head $4\frac{1}{2}$"); red bear, 2. Full details of the rules which now regulate hunting, shooting, and setting traps or snares in the above district were published in the *Punjab Gazette*, dated the 11th February.—*(Pioneer.)*

ESTATE *V.* STATE FORESTRY.

Disappointment has been felt regarding the lack of information in the Report and in the detailed evidence of the Royal Commission on Afforestation as to the situation and details of the land to be afforested. Of the suggested 9,000,000 acres, 6,000,000 are apportioned to Scotland, 2,500,000 to England, and 500,000 to Ireland. As is generally admitted, the proposals apply with much more force to Scotland than to England; and as the conditions relating to forestry are so very different in the two countries these remarks apply principally to England, where most of the money required to carry out the proposals would be collected. It is apparent, however, that of the 2,500,000 acres only a very small proportion of this would be in the south of England, or even in the Midlands. The large majority of it is in the north of England and in Wales, and consists of "mountain and heath land" situate up to 1,500 feet above sea level in out-of-the-way districts far from inhabited areas, where the cost of transport will be a very serious item.

One must agree with the report that something should be done to encourage forestry in this country, and also that forestry is especially important in checking rural depopulation and providing work during the winter for agricultural labourers and others accustomed to exposure in all weathers. The two questions of "afforestation" and "unemployment" should be treated, however, as two

entirely separate problems, and it is a matter of regret that they were discussed together. It is to be feared that bringing in the question of the employment of townsmen and "unemployables" will bring ridicule on suggestions to encourage forestry which everyone would welcome.

The report advocates State forestry almost exclusively, and makes few suggestions as to encouraging private enterprise on existing estates. The omission of estate forestry is all the more extraordinary when it is remembered that the principal arguments for afforestation are based on continental forestry, and that the large proportion of these continental forests belong to private owners and not to the State. Of the total area of woodlands in the respective countries, the "State and Crown" are returned as owing in France 11·1 per cent., in Germany 32·9 per cent., in Hungary 16 per cent., in Sweden 19·9 per cent., in Norway 12·5 per cent., and in Austria only 6·5 per cent. Even if the municipalities, communes, Church lands, and others be included, the majority is still owned by private owners. Surely in face of these figures the arguments given in the report under "Afforestation: a Task for the State," fall to the ground? If estate forestry is so successful in these continental countries, the question can reasonably be asked why, if forestry is to be undertaken in this country, private enterprise cannot be equally successful here?

The principal argument in favour of State forestry that can be gathered from the report is contained in paragraph 102. The commissioners commence the next paragraph with the assurance that they have tried to under-estimate the receipts and over-estimate the expenditure, but in the paragraph mentioned they say "the charge for rates can seldom reach *6d.* per acre." Apart from this small contribution to local expenses, there is no mention of heavy taxes nor of death duties, nor of many other impositions that the private owner has to pay on his woodlands. Mr. Rider Haggard, one of the commissioners, has since been reported as saying, "it may be necessary to relieve the State forests from rates and taxes which the land now bears." This is, indeed, a most important point to bear in mind when comparing the respective chances of

financial success of estate and State forestry, and is an advantage in favour of the latter that is not so apparent on the Continent. Considering the many advantages to the country that can be adduced in favour of estate as compared with State forestry, why should this advantage be withheld from the former ?

Assuming that the conclusions of the Royal Commission as to afforestation are sound, and assuming the advantages enumerated in the report accruing therefrom, it might be well to analyse the respective merits of a general system throughout England of estate and State forestry. The one advantage of the latter has been given above. There are, however, the following points in favour of estate forestry :—

1. The employment of private enterprise in place of State trading.—The advantage of this must be apparent to all, especially in view of some recent experiences of municipal trading. Not only are politics kept out of a commercial undertaking and influence out of the appointment of officials, but the private individual takes the risk. Private enterprise would have also greater facilities for ascertaining local experience and knowledge of conditions, soil, and difficulties—a knowledge which is especially important in forestry.

2. Existing woodlands would be taken in hand first.—There are thousands of acres of existing woodlands throughout England that would be replanted on up-to-date sylvicultural lines if only proper encouragement were given by the State. Coal, iron, and wire having replaced the purposes for which the underwood grown in these woods was required, landowners are commencing to convert these woods into growing timber. They are also now in a better position to do this, owing to the recovery on their agricultural land. If the State will remedy the present grossly unfair impositions on the woods enumerated in the *Field* of February 27th, 1909, large sums of money would undoubtedly be expended in improving existing woodlands. The experience acquired in this manner in the different localities would be invaluable in planting up new areas. There is scarcely any return from the majority of these woods at the present time, and owners are naturally more ready to spend money first to improve the income from existing woods.

3. The areas to be afforested would be more widely distributed, and far smaller parcels of land could be planted.—Only large areas in single blocks could be afforested by the State, but in estate forestry small areas, according to the soil and other conditions, could be taken in hand. The only serious addition to the cost is for fencing and wire netting; but this should be compensated by other advantages. Distributing the area would minimise risks of mistakes in planting unsuitable trees on unsuitable soil, and also risks from injurious insects and diseases. The commissioners call attention to the immunity from insect ravages that we enjoy in this country. This is possibly due partly to the wide distribution of our woodlands, but the case might be very different if large areas were planted with conifers or imperfectly acclimatised trees. Another advantage of these distributed areas would be that existing parish roads could probably be utilised, whereas the cost and unkeep of roads on mountain and heath land might be a serious item.

4. The areas on estates to be dealt with would be in close proximity to towns and inhabited districts.—This would check rural depopulation from existing localities rather than transport labour to uninhabited districts. Housing labourers on existing estates would be a small matter compared with finding accommodation for them on mountain and heath land. Even if the labourers could in some cases travel to and from work, as suggested in the report, the additional cost of travelling would have to be added to the labour bill. Estates and farm hands could be employed in the woods in the winter within easy reach of their homes, and, being natives of the district, they would be far more content than when transplanted to an uninhabited waste. The question of shops and the public-house would also be important. Most of the areas suggested in the report are apparently in the north of England, where the artisan class and townsmen predominate. Rural depopulation is not nearly so pronounced in the north as it is in the south of England, where we most require the creation of winter work.

5. Greater proximity of the areas to be afforested to land suitable for small holdings.—The commissioners advocate that the

afforestation of waste land would find work in the winter for those engaged on small holdings; but small holdings adjoining mountain and heath land would scarcely be much in evidence. There would be much more likelihood of small holders doing planting and other forestry work in the winter on existing private estates near the valleys and low land where the small holder is almost exclusively found. Whatever arguments can be given in favour of combining forestry and agriculture will apply much more to estate than to State forestry.

6. Ash and other hardwoods could be grown in addition to conifers.—The areas suggested in the report are almost exclusively confined to growing coniferous timber, but in estate forestry much more land could be found suitable for hardwoods. On some soils confers will, without doubt, grow faster and pay better than hardwoods. But before putting all our eggs into one basket we should consider other points. The large tracts now being planted are to meet a future demand for coniferous wood. We are much more experienced in the growing of our native trees than of conifers; the uses of our oak and ash are not likely to diminish; the present supply is essential, even if there is no increased demand, and for tensile strength and other good qualities our native timber can compete with the world. Apart from the danger of disease, where imperfectly acclimatised conifers are grown on a large scale, we should have also to compete with all the other countries, especially in the matter of pitwood.

7. A local market in each district for topwood and faggots.—The price realised for these, however small, would be better than the return obtained from them when grown far from inhabited areas. The cost of transport of the by-products of the timber from mountain and heath land might in some cases render them quite unsaleable.

8. The capital value of an estate is improved by forestry.—Landowners do not always expend money on their estates solely to derive a profit from the actual expenditure. Plantation and woods sometimes mean a permanent improvement to the estate, apart from any question of planting timber for profit. It is wise to place

proposals on a sound financial basis, but if compound interest were applied to all the expenditure on English estates as it is to forestry, fewer improvements would be carried out. It is said that many farms are let at a rent that represents only a small return on the cost of the buildings, and if compound interest were added to the outlay and improvements, rents of £100 per acre would have to be paid. Planting a bare hillside often means a great addition in value to the estate, apart from any return from the planting.

9. The value of the sporting rights attached to an estate is improved by forestry.—The value of sporting rights to an estate has already been dealt with in the *Field*, and the value of the young plantations for shooting encourages the owner to plant, and the rental value of the shooting to some extent prevents the compound interest mounting up. Rabbits are not required in our modern shooting, and the sporting rights need not prejudice the timber crop.

10. The value of the timber for estate repairs.—Apart from the local market for topwood and faggots, the thinnings of the plantations have a special value for repairs on the estate. The estate engine can also be utilised for coverting the timber, and in many ways there are facilities for combining forestry work with other estate work.

11. The value of the plantations for shelter to the estate.—Whatever importance was attached to the question of shelter in the report, it would have greater value on existing estates and "extensive culture" areas than on mountain and heath land.

Surely these advantages in the aggregate are worthy of consideration when discussing the question of aforestation, and yet the report says, "But in no circumstances do your commissioners suggest that the State should be expected to finance schemes of private afforestation by way of loan or otherwise." It is a matter of regret that the commissioners did not think it worth while to even consider the respective advantages of estate and State forestry. It might be advisable to enumerate a few suggestions as to steps the State could take to encourage afforestation by private enterprise. The first and most important point is the question of rates

taxes, death duties, and other impositions on woodlands. Having dealt with this question in the *Field* of February 27th, it is only necessary to enumerate the alterations from the existing state of affairs. Woodland should be included in the Agricultural Rates Act. Claims for extraordinary traffic of timber should be illegal. Expenses relating to inhabited houses, police, main roads, lunatics, and for national causes should also be kept separate in the rural districts, and woods and agricultural land should pay only one-fourth. The expenses for inhabited houses are included in the "district" rate in an urban area, of which rate agricultural land and woods only pay one-fourth under the Public Health Act. Clerks to assessment committees and councils should be instructed that woodlands are to be assessed in the proper spirit of the Rating Act, 1874, "as if the land were let and occupied in its natural and unimproved state." That the "natural and unimproved state" was not to be taken on the basis of the rent of the adjoining farm land of probably better soil, and the value of the farmhouse buildings and improvements included in the rent of such farm land.

Timber should not be treated as capital, and should therefore be exempt from death duties. Income-tax (Schedules A and B) should be properly assessed. The advantages of afforestation enumerated in the report are surely worth these simple steps to encourage private enterprise, and do justice to woodlands. In any case the other rate and tax payers would be saved expenses with reference to Poor Law, and this would be preferable to the State spending a large sum on afforestation. In addition to the above, the railway rates on English timber should be adjusted. Facilities should also be given to landowners when there is a difficulty of finding capital for the planting. Lord Lovat suggested a scheme to the present commission, in which the landowner should find the land and the State the capital for planting, the profits to be shared *pro rata*, the landowner also to have the option of recovering his ownership by buying out the State, with compound interest on the expenditure and some additional payment to cover the risks taken by the State. Facilities

might also be given to landowners to procure expert advice somewhat on the same lines as on the Continent.

Steps taken to increase the price of English timber would do more than anything else to encourage the landowner to plant. If he were assured that the timber when grown would ensure a satisfactory price he would soon start to plant on a large scale. The present unsatisfactory price of English timber is largely due to the want of wood industries, of better methods of converting and marketing, and of cultivating the use and market for it in the same way as is done by the foreigner. It is a pity the commission did not go into this part of the question, as there is a great want of an inquiry to ascertain what can be done in this way.

The report of the Royal Commission is unfortunate in two respects. In the first place it may have the effect of stopping the landowner planting, for fear of competition from the State in the sale of the timber. However nervous landowners may be of the report, they may rest assured that the opinions of the soundest members of the commission and legislature will prevail. Is it possible the commissioners brought out a sensational report so that this commission, at any rate, should receive some attention? Of the three previous inquiries with modest recommendations scarcely any notice has been taken. The other unfortunate effect of the report is that its greatest opponents are some of the most enthusiastic and able advocates of English forestry. There is the danger that their criticisms may be misunderstood and exaggerated, and thought to apply to afforestation and planting of every description. That the report is too optimistic few will dispute; that it is too socialistic many will agree; that criticisms should be made and remedies suggested is most necessary. These criticisms, however, when they relate to a subject so little understood as forestry, should be made in a careful and explicit manner, and in, as far as possible, a spirit of co-operation. It must be borne in mind that the class of politician which in the past has raised such cries as a "dole to the landlords" over the Agricultural Rates Act is now, after twenty-five years of indifference, almost inclined to do something for the benefit of the rural districts. If he is not met in a

sympathetic spirit, any further proposals will be drowned by "terminological inexactitudes" over slavery, religious disputes over education, or fanatical cries over beer.—(*By M. C. Duchesne, F. S. I., in the Field.*)

SYNTHETIC RUBBER.

It is interesting to note that the Synthetic Rubber Company, London, has issued a circular to the effect that the prospects of ultimate success in the production of artificial rubber are not sufficient to justify further expenditure on investigation, and the directors therefore propose the voluntary liquidation of the Company. This will cause much jubilation in the Straits, where the news that it was intended to produce synthetic rubber had a depressing effect upon rubber shares. It is probable that this circular is partly the cause of the present boom in rubber.

Photo.-Mechl. Dept. Thomason College, Roorkee.

Congested clumps, showing the new culms issuing from the centre.

Photos. by Basti Ram.

The lower portion of a congested clump.

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ESTABLISHMENT.

The steady development of the work of the Forest Department in India is well known. For the nineteen years, from 1887-88 onwards, it can be readily seen at a glance in the statistics of British India* recently published. It is also well known to those who are in touch with the department that, provided the means are supplied, the progress in the future will be even more marked. We have, however, we believe, now come to a very critical period on account of the inadequacy of the present staff and establishment. They cannot cope with more work than they have now; and, moreover, in many cases, they are already unable to do all the work that ought to be done. It may be said that the establishment in 1887-88 was certainly sufficient, and probably more than sufficient for the work at that time. The wisdom of the policy of maintaining an establishment more than sufficient to cope with the existing work in a young department with unbounded possibility of development, has been amply justified by the progress attained since then—progres that is markedly apparent from the statistics above referred to.

* Part IV (*b*)—Finance and Revenue, 1909.

Now although the cost of establishment has increased during this period by about 58 per cent, a great deal of this increase is due to the improved scale of pay in all grades, and it is certain that the establishment has not been increased in proportion to the increase of work. The work of the department has in fact, at the present time, developed beyond the capacity of the staff, and it is only on account of the extreme zealousness of the personnel of the department as a whole that this has been possible, otherwise there would have been a set-back ere this in the steady progress which has up till now been maintained. But even so, of late years had the staff been increased still further, the progress would have undoubtedly been greater still. At the present time the work all round is more than the staff can cope with—and while attention is being directed to one point, signs of retrogression in others are often indicated. We can safely assert that unless in the near future the staff is materially added to, future progress will be retarded ; and, on the other hand, we feel convinced that if the staff is strengthened, progress in the future more than proportionate to that of the past will be assured.

On March, the 10th this year, in the discussion following the reading of Mr. Eardley-Wilmot's interesting paper* on "Indian State Forestry" before the Royal Society of Arts, Sir James Wilson, K.C.S.I., recently Secretary to the Government of India, in the Department of Revenue and Agriculture, stated that he thought it was not fair to the present generation to charge all expenditure which was properly productive capital expenditure to the annual revenues of the year as is now done, and that he would like to see the Government of India following the analogy of its policy with regard to capital expenditure on railways and canals, set apart a considerable sum of borrowed money for capital expenditure on productive work in connection with the forests.

This seems to us to point out a reform urgently required, and were it carried into effect, the possibilities of future progress would be enormously increased, and it would set free a considerable sum of the amount now shown annually as expenditure. Part of this

* An account of this paper appears in this issue.

saving could then without disturbing the financial conditions be devoted to the urgent need of increasing the staff, not only to that sufficient to cope with the present work, but to a scale which will allow for expansion of work in the future and so insure accelerated progress.

In the review of Forest Administration in Burma for 1908-09, p. 155 of our issue for March 1910, we endorsed a suggestion made by the Conservator of the Pegu Circle to relieve trained officers of duties which might equally well be carried out by an untrained and therefore cheaper staff, and to appoint untrained men to carry out such duties. Such an arrangement would work well in many provinces and part of the necessary increase of staff could in this way be economically obtained at once.

The point, however, that we wish to emphasise is, that continued progress cannot be maintained by a department which is already markedly understaffed, and we trust that steps will be taken to expand the staff throughout the department so as to insure continued progress. If this is not done, and done soon, we are confident that progress will be seriously checked, if not stopped altogether. The extra expenditure involved would not be unproductive by any means and the increased revenue that would result would cover it many times over in a few years. We strongly advocate that an enquiry on this subject be instituted without delay in order to ascertain what additional staff is really necessary.

SCIENTIFIC PAPERS.

INDIAN STATE FORESTRY.

[CONTRIBUTED.]

An excellent paper on Indian State Forestry was recently contributed to the Indian Section of the Royal Society of Arts by Mr. Saint-Hill Eardley-Wilmot, C.I.E., late Inspector-General of Forests to the Government of India. The chair was taken by Sir William Lee-Warner at the afternoon meeting held on

Thursday, March 10th, the paper being read by Mr. E. P. Stebbing of the Indian Forest Service.

The author commenced by drawing attention to the fact that on two occasions only had State Forestry in India formed the sole subject of papers read before the Society. The first paper was read by the late Sir Richard Temple, who had evinced so great an interest in forestry during his administration of the Central Provinces and later of the Bombay Presidency. The second was contributed in 1890 by that eminent forester, Sir William Schlich, who for nearly a quarter of a century has been successfully engaged in building up an English School of Forestry, so that at the present time nearly the whole of the personnel of the Imperial Branch of the Indian Forest Service owes its training to him.

The subject had not, therefore, become stale by repetition, especially as, during the last twenty years, many changes and much progress had taken place in the forests of the Indian Empire. In spite of frequent set-backs due to famine and pestilence, the population of India had largely increased, and perhaps still more marked had been the extension of railways and of the feeder-roads that are necessary to their working.

"I select these two items, amongst others, that may be considered even more typical of the advance of civilisation in the Indian Empire, because they have the most important bearing on State Forestry, and because to them is largely due the corresponding progress in the successful practice of this science. It is admitted that to make the practice of forestry remunerative, it is necessary everywhere, especially in India, that there should exist a good demand for forest products and sure means of transport, and if it is realised that, with the exception of teak, sandal, and a few ornamental woods, such as ebony and rosewood, practically the whole of the timber out-turn of the Indian forests is consumed in the country, that of the very numerous items of minor forest produce only a portion of the most valuable is exported, also that forest products are, as a rule, bulky and heavy in proportion to their value, the importance of a multitude of consumers, with cheap and certain carriage at their disposal, is self-evident.

And of this there is ample proof in practice. Let, for instance, the forest conditions of the Provinces of Oudh and of the Central Provinces, be compared. In the former, cultivation is pressing on the boundaries of the small area of forest retained by Government in the plains, and the whole of the crop from heavy logs downwards, in some instances including even head-loads of dry twigs, has its market value, while the net revenue from the whole area, whether under timber, scrub or grass amounted, two years ago, to about £19 for each square mile; in the Central Provinces, on the other hand, it has happened that the yearly coupes remained unfelled though their out-turn was offered at the cost of its removal, while the revenue return was under £3 per square mile. In the one case we have to do with the very dense population of what has been termed the 'Garden of India,' with railways adjacent to the boundaries of or even running through the forests; in the other these advantages are not nearly so pronounced, though when they are present, as they some day will be, the 20,000 square miles of forest in the Central Provinces, then doubtless considerably reduced by the demands of the agriculturist, may yet rank in the value of their yield whit the now only partially exploited forests of Burma. It is directly referable to these important differences in the development of the provinces that the forests of Oudh are far ahead in treatment, in accessibility, and in comparative value of yield of those in the Central Provinces."

"The eager consumption of the products of the forests of India may be held to indicate the close connection of agriculture with forestry in that country. It will be admitted that the Indian peasant in the plains is not always adequately housed. Just as the 'two women grinding at the mill' may be seen now in any Indian household as they might have been seen two thousand years ago, so probably the peasant's residence has not much altered in style during centuries past. It is still constructed of material that is found or is grown in the locality. Doubtless many of us have observed that one of the first-fruits of rural prosperity in India is the erection of new buildings more efficiently designed,

both to withstand climatic influence as well as to render their owners more important members of the community. Thus agricultual depression has an immediate and important effect on forest revenues, whether that depression is caused by a restricted rainfall or by its unseasonable delivery, or is due to epidemics reducing the number and vitality of the population."

Proceeding, the lecturer pointed out that an area of 240,000 square miles was now under the control of the Forest Department representing a fifth part of British India, and that of the forests under Native States managed under plans compiled by British officers or administered direct by them were added, the total area under the department amounted to about a fourth of the whole of India. The forest area was, however, irregularly distributed. We should have liked to have had our 25 per cent. of the Empire's wooded area so distributed, that its produce would have been accessible to all its inhabitants, but we arrived too late; mankind had been warring against the forest with fire and axe thousands of years before our time and we have saved the rest. In the more densely inhabited tracts the forests have disappeared or been greatly reduced in extent as in the United Provinces and Bengal, for instance, whilst in Assam and Burma they are of great size.

"The forests are classified into 'reserves' which are areas demarcated and surveyed and having all rights and concessions with which they are burdened clearly recorded. The 'reserves' cannot be alienated without the order of the Supreme Government. Others are known as 'protected' and 'unclassed' forests. From these the 'reserves' of the future will be selected, and also such areas as may be required for cultivation. The 'protected' and 'unclassed' forests are practically open to the use of the populace, though they may not fell timber in them for sale without payment."

"The comparative importance of the large forest area of India is of course not so great as the same proportion would imply in Western countries; for instance, the value of the out-turn is not at present, area for area, to be compared with that of Western

forests. In the first place, though forest growth is by no means irresponsive to soil fertility, the Indian forests stand to a great extent, and especially in the more settled areas, on soil unsuitable for growing good field crops. And, moreover, they were, as I have said, taken over in a ruined condition, having been devastated by men, by cattle, and by fire. Such damage may be observed in every province of the Empire, though perhaps more apparent in the deciduous forests of Central India than elsewhere. The long-continued ill-treatment of the forests cannot be made good in one or even two generations of man; but it is satisfactory to know that the efforts of the last forty-five years are having an effect in improving the soil, and also the growth, as regards both quantity and quality, and to feel convinced that this improvement will keep pace with the increasing demand of the future."

"As matters now stand in the transition period wherein we now find ourselves, the forests of British India yielded in 1906-07 (later figures being, unfortunately, not yet available) 4,400,000 tons of timber and fuel, 181,250,000 bamboos, and £439,000 worth of minor forest produce; while they supplied grazing to 13¾ million head of cattle, as well as free grants and concessions of timber and other products, to the value of £227,000. The total income amounted to £1,776,000, and the total expenditure to £937,000. Of the latter, £66,000 was spent on roads, bridges, and houses; and £115,000 in demarcation, improvement, extension, and protection of forests. Establishments, comprising some 200 officers in the Imperial, and about the same number in the Provincial branch, together with some 15,000 members, I believe, of the subordinate and clerical establishments, cost £394,000. A net profit of £839,000 accrued to the State. These somewhat uninteresting statistics are given with a purpose; they tend to show that attempts are being made, and not without success, to increase the capital value of the State forests, not only as regards the standing crop of trees, but also as regards the ease of its removal, which implies, of course, an increased sale value. Moreover, when compared with the figures of 1889-90, statistics show that the gross revenue has risen by £850,000, and the net surplus by

£245,000. The percentage of surplus to gross revenue is still under 47, but it varies considerably in the provinces. There is still so much to do in exploration, demarcation, survey, working plans, roads, and buildings, that expenditure is certain to remain high for some years, but when these works, which tend to increase the capital value of the forest, approach completion and the out-turn is larger and its quality higher than at present, it seems certain that the forest income will increase even more rapidly in the future than in the past."

The author pointed out that in a country of the size of India stretching from the 8th to the 36th degree of north latitude and across 32 degrees of east longitude, with forests growing at altitudes varying from sea level to 14,000 feet elevation, with a rainfall from 500 or more inches in the year to an amount almost imperceptible to recording instruments, it would take more than a lifetime to become acquainted with the different types of forests and the conditions under which their inhabitants exist. Describing briefly the vegetation, the lecturer pointed out that at the upper limit came upland meadows carpeted with wild flowers followed by shrubby growth of juniper and alpine rose and below by birch and firs. Lower down came the oaks and rhododendrons at 8,000 feet, the elevation being marked by a heavy rainfall. The forests of cedar (the *Deodara* or 'Tree of God') and pine also grow at this elevation, whilst below them the long-leaved pine covered the hot rocky slopes and yielded both good timber and resin. At still lower elevations, the alder groves held up the shallow banks against the swift currents. In the submontane forests, the Shisham and Khair forests flourish on the banks and islands of the perennial streams, while the cotton and other soft-wooded trees are also to be found. Below the submontane occurred the Tarai forests. Here heavy grass jungle is accompanied by the deciduous forests which extend throughout the length and breadth of the peninsula and are found in Burma. They furnish the most valuable timber, such as Sal, teak, ironwood, sandal, rosewood, red sanders and ebony. The evergreen forests, where the trees grow to an enormous size with an impenetrable undergrowth, are found

towards the coast, and inland in north-east India. Then came the tidal forests of mangrove and Sundari, and lastly, across the Bay of Bengal, the primeval forests of the Andamans and Nicobars where existed the Padauk.

"This short description of some of the types of the Indian forests is, of course, quite inadequate, save to present some idea of their variety, but it will be conceded that it is of great national importance that an agricultural population who utilise to a very small extent the earth's mineral products should have a full permanent and cheap supply of its vegetable products on which, they are dependent as well for the luxuries as for the necessities of daily life. They need wood and bamboos for their carts, ploughs and other field implements; timber and grass for their houses and sheds; fibre for their ropes and lines; reeds for their mats; bark for tanning; leaves for thatching and for manuring their fields; dyes, gums, resins and oil for various domestic purposes; fruits, flowers, and roots for food and for alcoholic drinks; while the collection of minor forest produce brings work and money to the community. In short, though the people are still apt grossly to ill-treât the forest, preventing regeneration by grazing and firing, removing the sapling growth to save the labour of conversion and only sparing maturity on account of its bulk, they are beginning to recognise that the forest in its regulated form is no longer as of old the enemy of man, and that they cannot do without its produce, although they may individually resent the wise policy of Government in prescribing rules for its use."

So much for the direct benefits conferred by the forests. The indirect ones are as worthy of consideration. One of the most important is the influence of the forests in the regulation of the water-supply. Sir Richard Temple had drawn attention to this point, but so little attention had been paid to his lead that in the Report of the Irrigation Commission published a few years ago, no allusion was made to this factor, and thus one-fourth of the Empire was left out of consideration in arriving at its conclusions. Both in Europe and America this question was receiving the closest attention and the time had surely arrived in India, where the food of the

people is so largely dependent not only on the amount, but on the timely distribution of the rainfall, where there are vast irrigation works in existence, in construction, and under consideration when the question of water storage in the soil should receive the attention it deserved. Difficulties there were in the way. The greatest perhaps being due to the fact that the sources of many of our chief rivers in the north and of those which emanate from the Central Indian plateau and elsewhere are now mostly in Native States and so out of our control, and we rightly demur to any practical interference with the forest management of those who are now our loyal friends. To regulate the water-supply in the plains we must have access to the watersheds of the upper reaches of the rivers and systematic work over a term of years would be necessary before we could produce any impression.

The author then proceeded to point out some of the results of forest denudation. He showed out in the Upper Himalaya the trees acted as living piles to support the heavy snowfalls and prevent them sliding down in the spring in the form of avalanches. On the lower hills the rainfall is more dreaded than the snow. Here the protection of the forest is required to prevent the slopes from being scoured by the action of intermittent torrents that are powerful enough to remove the surface soil and cut deep ravines into the hillsides. Fire and excessive grazing soon destroy all protective vegetation and the villagers lower down see their houses swept away and their fields covered up by avalanches of mud, rocks and stones. The people also suffer owing to the resulting dearness of fuel. For instance, the southern slopes of the Simla Hills are bare of forests, and wood fuel sells amongst a population of 40,000 souls at over £1 per ton, delivery not included. If these slopes were wooded, as they certainly were in the past, their owners would now be wealthy, and the stability of the slopes would be better than is the case at present.

Another aspect of the case is to be found in the enormous hydraulic power now running to waste. Until we regulate the flow of our rivers to some extent they cannot be remuneratively harnessed for commercial purposes. Satisfactory developments have

been commenced in this direction. Hydro-electric works are in process of erection on the Jumna and Sutlej rivers, and are actually working in Native States on the Jhelum and Cauvery, whilst the protection of catchment areas is receiving attention in Kashmir, in the N.-W. Frontier Province, in the Punjab, U. P., Bengal and even in Burma. Forest denudation in Sikkim was reported on by an Indian forest officer at the instance of the Duars planters who were suffering from erosion in the hills above.

"The objects of State Forestry are then, as I understand them, to secure to an agricultural population those direct and indirect benefits which the forests confer, and to further the industrial development of the country. Incidentally, the export of teak always a royal monopoly in the principal area in which it grows and the sale of other woods which the people can do without, such as deodar for public works, rosewood and blackwood for cabinet-making, and also the disposal of the excess crop of minor produce, such as myrabolam, lac, wax, etc., brings in money to the State, which again enables more to be spent on improving the public forest estate property and increasing its yield."

"The chief factors leading to success in Indian forestry are familiar to us all; they have been adopted wherever Englishmen have been called upon to administer British possessions in the East, and consist in personal influence and in education."

"The part played by the Indian forest officer has been in the past, and, on the borderlands of our less settled provinces still is, that of a pioneer, and he soon learns the lesson that there is in his calling—perhaps more markedly so than in others—no success without the goodwill of his neighbours, and that he cannot overcome their distrust, save by kindly tact, or be able to command their aid, until he first possesses their confidence. In many of the wild tribes, amongst whom he lives, he is the best known representative of a distant Government, and happily the instances are not rare where the foundations of sylviculture have been laid with the aid of the aborigines, and where they are successfully entrusted with the protection of the forests in which they live. I shall have always kindly memories of the Thibetans, who bring down borax

on packsheep and goats, and do infinite damage by lopping the forest trees for fodder, and yet naïvely assume that they are welcome to call and sit round your camp fire; of the Tharus, the best cultivators of rice in the plains of the Tarai, and also the most inveterate destroyers of game with guns, pitfalls and nets; and of the Gonds of Central India who will follow all day, better than a bloodhound, the track of buffalo or bison, and in the evening take a bee-line for camp across the pathless forest."

The author then proceeded to deal with the protection of the forests, and nowhere he pointed out was the personal influence of the forest officer more apparent than in the records of fire-protection.

"The abandonment of the very ancient custom of burning the forest for the various reasons of temporarily improving the grazing, of providing facilities for hunting, or for destroying the hiding-places of dangerous animals, is one of the most difficult lessons to teach the people, and it is a duty whose successful issue most surely points to the hold the forest officer has on them. In 1906-07 there were 44,400 square miles of forest under special protection that is surrounded and intersected with cleared fire traces with watchers stationed on the look-out day and night, and of this large area less than 6 per cent. was burnt over, complete success being attained in some provinces. Another notable example of personal influence is shown in the establishment of forest villages, whose inhabitants, while cultivating small areas for food-crops on lightly assessed or free land, find their chief occupation in forest labour and in collecting its products. In many places it is only possible, by a system of this kind, to procure workmen in forest areas which the ordinary Indian peasant is fearful of entering."

The great importance of the forests to the State in times of scarcity was dwelt on. They were then thrown open to the people and their cattle without restraint. In the famine of 1896 no less than 115 different kinds of edible roots, fruits, buds and seeds were utilised for food by the people of two districts of the United Provinces.

The lecturer then dealt with the personnel of the department. He pointed out that the forest officer must not only have a good

professional training, but also a knowledge of surveying and engineering; that he occupied the position of a land agent with an estate of 1,000 square miles or more to administer. If to the above qualifications he can add a special knowledge of botany, chemistry, zoology and geology with an intimate acquaintance with modern languages, he should be considered an efficient servant of the State. Forty-five years ago forestry as a science was unknown in England. The name of the late Sir Dietrich Brandis will always be remembered as the founder of Indian forestry, and his successors Sir William Schlich and Dr. Ribbentrop worthily continued his labours. Between 1869 and 1881 the officers of the Imperial Service studied their profession in France and Germany; up to 1905 at Coopers Hill, and since then the University of Oxford has been entrusted with their probationary training. The students still visit selected forests in France and Germany during their practical training. Mr. Eardley-Wilmot stated that he considered that whilst these visits are still necessary, there should also be a period of probation in India devoted to a well-organised introduction not only to the sylviculture, but also to the language, customs and feelings of the people with whom the forester must either sympathise or fail. It is due to the peasant of India that no forest student, however accomplished in the theories of his profession, should enter into authority over them until he has in practice learnt something, not only of the duty of the people to the forest, but also of the duty of the forest to the people. Such knowledge can only be acquired, as I have before suggested, by a period of probation in India, to be passed preferably under some system of instruction in the field and class-room, which may be suitably designed by those who have a sound practical knowledge of the conditions of the India of to-day. I consider that it would be wise to rule that no forest officer shall be finally gazetted to the service, whereby he acquires *ex officio* considerable powers until he has passed through some such preliminary training, either in the province to which he may have been appointed, or failing opportunity there, at one of the Indian forestry colleges.

In addition to the Imperial branch of the service we have the Provincial and Subordinate Branches. The Provincial has consisted

in the past of men recruited from the ranger class of the subordinate service, these men having received their forest education at Dehra Dun. During the last few years it has become recognised that there were great drawbacks to this system and a special course of an extra year to be spent at Dehra by such rangers as may be selected for early promotion has been prescribed.

Provincial Governments are also inaugurating local schools of their own for the training of Rangers, and it is hoped that in time the Dehra College will be able to confine itself to the training of the Provincial Service Officer alone.* Forest schools and colleges have also been established in Burma, Madras and Bombay; these two latter institutions forming part of the Agricultural colleges: the tuition of the two subjects will thus proceed side by side to the advantage of both. Finally, we have at Dehra the Forest Research Institute which was created in 1906. The officers filling the Research posts have all been drawn from the service, and a considerable amount of progress has been made in investigations into the zoological, botanical, sylvicultural, chemical, and economic problems of the forests.

The lecturer then drew attention to the recently greatly improved prospects of the officers of the Imperial Service. It was unfortunate that the grant of similar concessions to the Provincial Service should have been so long delayed.

The amenities of the forest officer's life were touched upon. He could prosecute big game shooting in the course of his ordinary avocations which were carried out, often amidst the most beautiful scenery. The conditions of life also were now far easier than formerly since the forests were now demarcated and opened out to a great extent by good roads and furnished with good rest houses.

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* The state of affairs has altered since the author left India. We understand that it has been decided to retain the Ranger class at Dehra and to train there all rangers for the Bengal Presidency, excepting Burma. Then, instead of continuing the temporary expedient of tacking on an extra year's course to the Ranger course for the training of probationers for the Provincial Service, we believe that it is proposed to have a separate two years' course for Provincial Service recruits, to simplify the Ranger course and to keep the students in the two classes entirely apart.—**HON. ED.**

We seniors may well feel envious of those who are now on the easier road to the completion of the good work that has been so well begun.

The Chairman, in congratulating Mr. Eardley-Wilmot on his excellent paper, said that he strongly agreed with him on the extreme importance of the forests to a country such as India. He said that he considered that all the departments of the country were dependant on the successful work of the Forest Department, and that it was of great importance that this fact should be fully realised.

He deplored the absence of Sir William Schlich, who had telegraphed his inability to be present. Sir James Wilson said that as Revenue Secretary to the Government of India he had cordially co-operated with Mr. Eardley-Wilmot in the numerous schemes he had produced for the improvement of the prospects of the department and that results of great value had ensued. He said that after a close study of the position he was of opinion that the Government of India should allot annually to the Forest Department a sum of money to be solely devoted to the improvement of the forests of the country upon which he did not consider a sufficient sum was expended.

After one or two other members had spoken, a vote of thanks to Mr. Eardley-Wilmot and Mr. Stebbing, the reader of this paper, was proposed by the Chairman and seconded by Colonel Yates, who made a few remarks on the forests of Baluchistan, and said that when Agent to the Governor-General he had taken every step in his power to forward the forest policy of his forest officer, who was a native of India, and a right good man.

NOTES ON THE FORESTS OF HEPPENHEIM IN HESSE-DARMSTADT.

BY F. COWLEY-BROWN, I.F.S.*

The following account deals merely with such salient points of the system of management in the Heppenheim forests as appear

* Reproduced from his "Reports on Certain Continental Forests." Madras, 1908.

to have special application (whether by force of similarity or contrast) to the conditions of forest administration in India.

The subject naturally divides itself into four heads :—

I.—Extent, situation, nature and tenure of the forests.

II.—Establishment and administration.

III.—Sylvicultural method adopted.

IV.—Miscellaneous.

I.—The forests of the Grand Duchy of Hesse-Darmstadt extend over about 611,000 acres or nearly 32 per cent of the total area of the State. Those of the Heppenheim district cover some 4,500 acres, and are typical of the forests found generally throughout this State.

The Heppenheim forests clothe the hills to the north-east of the village of that name and form a cap to this undulating range, but rarely descend more than half-way down the slopes. The lower portions of the hills are occupied with cultivation, which occasionally pushes up like a wedge into the heart of the forest on the summits.

Under the collective title of Heppenheim Forests are included, in this note, those of Hambach also, as the two form the charge of the Heppenheim Forstmeister.

The growing stock consists mainly of beech and oak, mixed with a considerable quantity of Scots pine, and a lesser extent with spruce, ash and silver-fir. Birch is also common, but is of so little value, and is so persistent in its intrusion, that it is now regarded in the light of a weed. Species of minor importance, such as hornbeam, alder, etc., also occur.

The underlying rock is chiefly granite and diorite with veins of schist, and forms an admirable foundation for the magnificent roads that are one of the leading features of the forest district.

The resultant soil is mainly a sandy loam with out-crops of rock and boulders. Clay also appears sparingly. The ground is fairly moist, and owing probably to inversion of strata and faults, springs are plentiful, especially in the depressions and gullies.

The beech does exceedingly well in localities, and under treatment, suited to it. Its requirements here consist mainly

in a well-drained and fairly rich soil, scientific thinning and the careful preservation of the leaf mould. Reference will subsequently be made to this latter point. The oak, on the other hand, can scarcely be regarded as successful under the treatment to which it has been subjected until within recent years.

In the ravines and marshy ground, ash is in a very flourishing condition. Spruce almost wherever it has been tried has been found thoroughly satisfactory in its results. But Scots pine has not done at all well on the whole, nor is the larch much more prosperous. There are some fine specimens of silver-fir scattered about, demonstrating the promising possibility of this species under proper conditions. The birch is thriving everywhere.

The majority of the forest area throughout the Grand Duchy is not the property of the State, but is owned either by communal bodies such as villages, corporations, etc., or by private individuals; the proportion being as follows: 38 per cent communal forest, 32 per cent private forest, while the remainder belongs either to the State or to the Crown (Privy Purse).

The management of the Crown forest is however entirely entrusted to the care of the State.

Over the communal forest the State exercises, through the Forstmeister, practically complete technical control, but in theory the Forstmeister has to consult the head of the community on every matter upon which he proposes to take action. It is his duty to keep the Mayor (or equivalent official) fully informed on all points and to give advice. In the event of the community failing to agree to the Forstmeister's proposals, the question is referred for definite settlement to the Ministry of Forestry and Finance. The situation is therefore somewhat analogous to the dual administration of civilians and forest officers in the Madras Presidency, but in the Grand Duchy the welfare and technical needs of the forest are seldom subordinated to "political" exigencies. And this for two reasons—Firstly, there is rarely any acute economic question, and secondly, the communes are thoroughly imbued with a sense of the desirability of forest conservancy. In

act, every German may be said to have grasped and to appreciate the principle and *raison d'être* of reasonable forest management. There is thus little or no friction.

The situation may be summed up by the following quotation from section 37 of the Organic Forest Law of January 1811.

"In the technical treatment of communal forests *the Oberförster do not serve under the Magistrates*, Councilmen, and representatives of communes, *but only under the higher State forest authorities*, whose orders they must closely follow. They must never forget however that they are administering the property of others, that their rule must have no other aim than to further the good of the communes, that they owe the representatives of the commune respect if not obedience, and that it is their duty to confer with the communal authorities even about the technical treatment of the forest, and to take into account their views and wishes, and to give information upon any phase of administration when it may be asked for."

The result is a harmonious system of working that annually presents to the community a handsome financial surplus (the communal and State forests yield about 18 shillings per acre nett per annum) which goes far towards reducing taxation, etc., while a practically free supply of small timber, fuel, and minor forest produce is assured to the inhabitants. In the event of exceptional expenditure being required for such purposes as the building of a church or school, the forest authorities endeavour to meet the local necessity by increasing, under due sylvicultural safeguards, the exploitation area for that particular year. Incalculable benefit of an indirect nature is also conferred in the way of hygienic amelioration, improved rainfall, water-supply, evaporation, shelter from winds, etc. The position is in fact a most satisfactory example of the principle of give and take, and may be regarded as an ideal to be continually held in view by those entrusted with the administration of the forests of India.

So far as the State forests are concerned, private or communal interests are naturally not considered in principle unless established as a right, and this policy can scarcely be looked upon

as unreasonable or as productive of hardship, considering the large forest area vested in communal or private owners.

The forests of the latter class are but little interfered with by the Forstmeister, who merely "over-sees" them. Their technical treatment is left very much to the direction of the owner, who however is not permitted to abandon or disafforest them or to convert them to purposes of agriculture without express permission of the Government. Moreover in most cases measures must be guaranteed for regenerating within a certain period any area felled over.

II.—Each forest district in the State is in charge of a Forstmeister, whose position is in some ways analogous to that of a District Forest Officer in Madras. He is directly subordinate to the Oberforstmeister (or Conservator), while the latter class (six in number) are controlled by the Grand Ducal Department of Forestry and Finance.

When the working-plans of a district are under revision or renewal, a Forst Assessor (working-plans officer) is specially posted for this duty. The executive work is carried out by forest guards, each of whom is usually in charge of about 750 acres. In the Heppenheim district there are nine guards—a relatively large number rendered necessary by the numerous small forest areas scattered throughout the district.

The Heppenheim Forstmeister is in charge of about 4,500 acres of communal forest belonging to the Heppenheim and Hambach villages, and of a very small area of State and Crown forest. He also has to exercise a general supervision over about 1,250 acres of private forest.

One clerk (usually employed for half the day only and paid accordingly) is attached to the Forstmeister for scriptory work.

Taking the Conservator's circle in India as the unit, the following comparison between the areas and establishment controlled by the officers of each class is suggestive.

Hesse Darmstadt.	India (Madras).
1 Oberforstmeister controlling 101,000 acres.	1 Conservator controlling 3,840,000 acres of reserved forest.

12 Forstmeisters controlling 8,400 acres each.	8 District Forest Officers in charge of 480,000 acres each.
Perhaps 8 Forst-Assessors	6 Assistant Conservators and Extra Assistant Conservators.
	30 Rangers.
	40 Deputy Rangers.
	50 Foresters.
About 135 forest guards each in charge of 750 acres.	400 Guards each in charge of 10,000 acres.
	500 Watchers.
	An indefinite number of fire patrols, permit-issuing officers, thanadars, etc.
Perhaps 12 clerks ..	At least 100 clerks for the Circle.

That the enormous army of subordinates maintained in India is not necessary in Germany is due to the fact that the German peasant is naturally of a law-abiding disposition, that he entirely approves of, and respects forest policy, and that the departmental subordinates are as a whole thoroughly loyal, enthusiastic and trustworthy.

The duties and life of a Forstmeister similarly differ greatly in nature and scope from those of his brother officer in India.

The former is entirely relieved from all financial account or audit work. He merely signs pay slips for his subordinates and heads of working gangs. These slips are then presented at the local treasury by the payees. The savings of work, worry and responsibility thus effected can better be imagined than described. The German Forest Officer's energies and time are almost solely confined to their legitimate sphere, *i.e.*, the management and sylviculture of his forest.

There is but little crime, and usually no grazing or fire-protection. Consequently, when out on inspection, he can spend the

whole day in his forest, and is not harassed and driven back prematurely to office by the thought of a depressing and ever-increasing accumulation of "tappal," consisting mainly of accounts, muster-rolls, offence reports, and sins of omission as well as of commission.

Blessed with a charming climate and environment, ideal forests developed to their highest possibility by the most scientific management, an appreciative administration, and a sympathetic population, it is no wonder that German forest officers are content with about one-fourth of the emoluments of their Indian confrères.

III.—The system of management adopted in the State is Judeich's method—or rather a revised Judeich's method—and is in effect a highly developed group system.

This method considers each of the several woods constituting a charge, rather than the forest as a whole, and deals separately with these woods as required. Other systems usually regard the whole area under treatment as a simple unit. The yield is next determined and the portions of the forest from which it can best be obtained is then decided on.

Judeich considered that the "ripeness" of each wood should be based on financial considerations, but Dr. Schlich takes the view that the "objects of management" ought to be regarded as the determining factor in deciding the question of the "ripeness," a view with which Indian forest officers generally will be in complete accordance.

The past history of these forests may be summed up as an alternation of periods—neglect with those of meddling and often unscientific interference—due possibly to the personal idiosyncrasies of previous heads of State.

Consequently when within recent years it was decided to make a determined effort to base the management of the forest upon proper scientific principles, it was found that the problem confronting the administration was the restoration of a half-ruined property.

Special and peculiar measures were therefore necessary, such as would not have been adopted had the area been mainly clothed with more or less normal forest.

Consequently in the Heppenheim district no definite rotation has yet been laid down for the various species. It is considered that probably 120—140 years will be the most suitable period for the oak and 120 years for the beech.

The forest is divided into compartments mainly with reference to feasibility in working and topographical divergencies. Each compartment is then subjected to a detailed valuation survey and sub-divided into groups in accordance with the quality and condition of each clump or cluster of trees. [Owing to the poverty of English sylvicultural terminology it is necessary here to have recourse to such clumsy colloquialisms as "clump".] The object of the grouping is to ensure that each group will comprise such area of the growing stock as demands, by reason of similarity of species, age or condition, the same sylvicultural treatment. The groups vary in size from two or three acres to very much less. A group may be split up into two portions some distance apart, but each portion of the group must be situated in the same compartment.

Each group, after being surveyed and valued, is separately entered in the compartment description of the working-plan, in which are shown the fullest details of situation, aspect, area, species, quality, height, density, health, future treatment, etc.

As regards future treatment, one species is usually selected as the principal species, and the whole group treated with reference to that species mainly.

It will be readily conceived then that the working-plan presents a mass of detail and minutiæ probably far surpassing that of any other system, and that the work of surveying, valuing and grouping the crop imposes a heavy strain on the discretion and energy of the Forst-Assessor. In theory the actual calculation of the yield is greatly facilitated by the use of yield tables, which have been prepared during the last century for every class and age of the principal species. But in this expedient lies perhaps the weak point of the whole system. For yield tables are never too reliable even when dealing with large areas in a large way. And naturally the errors are greatly increased when almost every few roods are subjected to a detailed valuation and survey. In

practice, a any rate, it is found here that the yield tables are not reliable. To this contention theory replies that the errors will counterbalance each other and that the sum total will give a very fair indication of the crop on the ground. It might be fairly suggested that the errors may or may not nullify each other, and there is at least a risk that they will aggregate rather than minimise the final discrepancy. Apart from this point however there can be no question that this development of the group system results in working the forest to its highest possibility. It may be regarded therefore as the ideal of scientific management to be stored in the memory of all forest officers. But whether the enormous expenditure of labour, energy and skill might not be more profitably utilised is possibly open to question. It is still more a matter of doubt whether even the most advanced Indian forest will ever be ripe for, or would benefit by, the application of such an intricate and detailed method, which a late Conservator would perhaps have included in his category of "amateur gardening operations." But as an example of the highest scientific management and of advanced sylviculture the Heppenheim forests form a most valuable object lesson for every Indian officer.

One most salutary regulation in force should be particularly noticed, *viz.*, that every working-plan must be not only revised but actually renewed every ten years. In many cases of course the renewal amounts to no more than a revision ; and as a rule the numbers and as far as possible the boundaries of the compartments remain unaltered, but the groupings are usually subjected to considerable modifications and changes, as may be dictated by increased experience or by the improvement or the reverse in the quality of the stock composing any one group. It will be evident that where mistakes have orginally been made or errors have subsequently crept in, such a provision is of the utmost value as an automatic safeguard, and goes far towards diminishing the risk involved in the adoption of the system of calculating the possibility by yield tables.

The labour and expense necessitated by this regulation form of course a very serious item in the budget, but are more than

justified by the advantages gained. India too has of late years begun to see the necessity for some such provision against mistakes, and recent Indian working-plans have generally contained a prescription to the effect that the scheme should be revised at least after 20 years. In fact the old working-plans for high forests laying down details of management for 100 or 120 years (while the actual composition, or at any rate the sylvicultural requirements, of the growing stock were comparatively unknown factors) are happily now being regarded as obsolete and unworthy of reliance.

Although the Heppenheim district has been described as consisting of partially ruined forest, there are to be found in it several examples of the magnificent results that have been obtained by the application of a suitable treatment to a stock happily situated amidst first-class factors of locality. As instances may be quoted :

(1) Compartment 18, Meadow land 63 years ago. It is now stocked with ash 5′ high, and beech 102′.

(2) Compartment 1, Steinschloss, containing beech and oak, 85 years ; the sixth thinning was made in 1902 and 1905 when over 2,500 c. ft. were taken out. The canopy is already completely established since this last thinning, which was undertaken and carried out entirely by the forest guard!

(3) In another compartment, now 60 years old, the first thinning in 1886—88 produced about 850 c ft., the second thinning in 1893-94 yielded 777 c. ft., while from the third thinning two years ago 2,119 c. ft. were obtained—an actual result far above the forest of the yield table!

(4) A wind-fallen silver-fir, 125 years, measured 124′ 8″ without the top, and this length of bole contained 300 c. ft. of timber.

In this district 1′ 6″ diameter and 80′—100′ in height are regarded as the probable maxima. The rotation of 120 to 140 years is perhaps altogether too low, considering that in the Bavarian Spessart a diameter of 2′ is not expected under 300 years, when a price of 10*s*. per c. ft. cut in the forest is realised. It would seem that the best chance for the oak in Heppenheim is to leave it in carefully-tended groups. Although magnificent beech can be produced here, it fetches only the wretched price of 1*s*. per c. ft.

cut in the forest, while for ash three times that price can be obtained.

IV.—It is found that the reproduction and prosperity of the beech are enormously favoured by digging on the slopes small ditches, following the contour lines, to catch the drifting leaves wherever the prevailing wind is suitable. The beneficial effect of these ditches extends even to the foliage crop, as beech that, before the ditches were made, would not put on leaves now annually produce a full quota of canopy. On the denuded sides of hills in India the construction of such ditches should prove of the utmost value, both for ensuring cover to the ground, and for breaking the force of the rain washing down the steeper gradients.

As before mentioned a prominent feature of the district is its splendid system of roads that define the contours in every direction, and by rendering the forests accessible at every point enormously increase the nett value per acre. The task of road-making is greatly facilitated by the durable nature of the underlying granite and diorite, than which no better material could be asked for. Road construction is usually given out on contract by sections—the Forstmeister, as already stated, merely signing the pay slip of the headman of the gang. Very little departmental work in this connection is undertaken.

Christen's height measure (described in Schlich, Volume III) is commonly used in valuation surveys. This instrument is very portable, requires no tape or horizontal measurement and up to 80′ is very fairly accurate. Above that height the personal equation becomes rather an important factor in its use. For Indian work there is probably no better instrument in the market.

Some of the lessons taught by a study of these forests might be laid to heart not only by Indian forest officers but also by British landlords—so many of whom are only too ready to declare that forests in Great Britain and Ireland are not required, that they would not pay, and that the timber can be imported cheaper than it can be grown. Such contentions are perfectly accurate as long as it is proposed to continue the attempt to produce or to manage forests on the faulty principles that have dominated the old school

of British foresters. But surely 18*s*. per acre per annum nett in favourable cases (and an average of 11*s*. throughout Hesse), the physiographical benefits conferred by well-wooded acres, millions of pounds kept in the country and employment given to hundreds of thousands of labourers, are financial, sanitary, and political advantages that are at least worthy of more consideration than summary rejection without detailed inquiry?

The compiler is deeply indebted to Herr Gundlum (Forstmeister of Heppenheim), to Mr. N. Jolly (Probationer for the India Forest Service), and to Forst-Assessor Vogt for the great assistance they afforded him while examining the forests of Heppenheim, as well as for their many kindnesses in personally explaining and demonstrating the chief points of interest.

ORIGINAL ARTICLES.

THE BAMBOO (*DENDROCALAMUS STRICTUS*) FORESTS OF THE GANGES DIVISION, U. P.

The chief object of the present article is to draw attention and invite discussion on the management and working of bamboo forests in a locality where the demand is very great and consequently the working intense. The Ganges Forest Division supplies a large portion of Upper India with bamboos, and hence this species is of great economic value while there are several points connected with the growth and treatment of *D. strictus* which require elucidation.

To fully understand the present working of the bamboo forests of this division, to realise the sylvicultural problems with which we are faced and the difficulty of meeting defects in the method of working, it is very necessary to understand the past history of these forests, the gradual evolution of the present method of working and the reasons which have led, from time to time, to changes in the system of management.

Uprooted congested clump
showing the low cut stumps on the outside and the dead rhizomes round the periphery.

Photo.-Mechl. Dept. Thomason College, Roorkee. Photos. by Basti Ram.

Uprooted congested clumps shewing the dead outer rhizomes.

THE BAMBOO FORESTS OF THE GANGES DIVISION, U. P.

PAST HISTORY.

The forests now dealt with lie on the lower slopes of the Himalayas, between the Ganges and Ramganga rivers, in the civil district of Garhwal.

From the commencement of British rule in these hills, down to the year 1868, the forests along the Sub-Himalayan tracts from the Ganges to the Sarda were managed by the civil authorities, who farmed out annually the right of exporting timber, bamboos and minor forest produce from this large area to various lessees for lump-sums aggregating from Rs. 4,000 to Rs. 6,000 per annum. These lessees established posts along the outer edge of the forests at which their agents collected duty on timber and all other forest products. These posts were known locally as "kât-bans" choukis, from the words "kat" meaning timber, and "bans," bamboos, as these were then the most important products exported. The kat-bans choukis were opened every year at the commencement of the cold weather, and then any one might enter the forests and cut and remove whatever he liked, provided only that he exported the produce through one or other of these choukis, and paid the tax fixed for the particular kind of produce exported.

There was no restriction as to the size, age or number of trees which might be felled, nor was there any rotation for the working of the bamboo forests. The natural result of this system of unrestricted felling and cutting was the gradual deterioration of the tree, and bamboo forests which were easy of access either by road or river, or situated near large towns or other centres of demand.

In about the year 1862, Sir Henry Ramsay, who was then Commissioner of the Province of Kumaun, realising the enormous damage which was being done to these valuable forests, introduced a few simple rules restricting the felling of trees of the more valuable species, and this was the first attempt at forest conservancy The unrestricted cutting of bamboos was, however, continued.

In the year 1868 the forests came under departmental control and as there was then no Forest Act, a set of forest regulations were drawn up, but the system of kat-bans choukis was continued with the new departure that dues on timber, bamboos and

other forest produce were collected by departmental agency, fixed and higher rates were established, and certain restrictions were imposed on the felling of the more valuable trees.

Down to the year 1883 no attempt had been made to introduce even the simplest sylvicultural rules in the bamboo forests, and at that time the bamboo areas are reported to have been in a bad condition, and Sir D. Brandis, who visited these forests in that year, was so dissatisfied with their state and the method of working them that at his instigation the two following innovations were introduced. *First*, contractors were ordered to leave not less than four growing culms in each clump.

Second, the royalty rates on bamboos were revised with a view to lessen the export of the thinner bamboos. It was, however, found impossible to enforce the first rule, as the areas worked over were so extensive that proper control over the bamboo-cutters was out of the question, and hence this rule had to be abandoned. In 1885-86 and subsequent years, various schemes were drawn up to only open certain areas yearly, so as to give the forests a period of rest, and the clumps a chance of recuperation, but it was not till the year 1890-91 that the bamboo forests of the Ganges Division were brought under a fixed scheme and under a regular set of cutting rules, and this scheme and these rules (with some modifications) are those now in force.

PRESENT SYSTEM OF WORKING.

The scheme of 1891 was drawn up by Mr. B. B. Osmaston, and its three main provisions were :—

1. The forests were divided into blocks which were opened and closed in alternate years, thus giving a two-year rotation.
2. No shoot less than one year old was allowed to be cut.
3. Bamboos were not to be cut more than one foot above ground level.

The present working-plan of the Ganges Division was drawn up by M. Fr. Beadon Bryant and was published in 1896, and the two-year rotation was adopted for the bamboo forests. A few years after the introduction of this plan exception was

taken to the shortness of the felling rotation of bamboos, as it was thought that the clumps were being too heavily worked, and that the size of the culms was diminishing while the reproductive power of the root system was being reduced. Various suggestions were made from time to time with a view to reducing the intensity of working, but no definite practical solution was found which could be rendered effective ; as this question, however, touches on the sylvicultural requirements of the bamboos, it will be dealt with in the next section. It was noticed that the greatest damage by heavy cutting occurred in the forests nearest the lines of railways and in the proximity of the larger rivers, and hence it was decided in the year 1904 that the bamboo forests should be divided into two series: the first series, consisting of the more accessible forests, being worked on a three-year rotation, while the second series of the more remote forests should continue to be worked on the two-year rotation. This alteration in the prescription of the working plan was sanctioned by Government in May 1904, and was brought into operation the same year, and has continued in force up to the present time. The felling rules are the same as those introduced in the year 1891.

SYLVICULTURAL REQUIREMENTS OF *D. strictus*.

The seed of *D. strictus* germinates at the commencement of the rainy season and as the young plant increases in age new rhizomes are formed and these increase in size and throw out larger culms, till from 10 to 12 years the clump reaches maturity, and then full-sized culms are produced annually till the clump flowers, seeds and dies. The actual age at which a clump flowers is not known, and this probably varies according to the quality of the soil and the intensity of working. Drought and heat appear to have a marked effect on the seeding of bamboos. Sporadic seeding is common to this species, and sometimes only some of the culms* in a clump will seed, while the remaining culms continue to live and may seed during the next

* In such cases further investigation will probably show the clump really consists of two or more clumps growing intermingled.—HON. ED.

year. Although this species is capable of bearing fairly heavy over-head cover, it undoubtedly flourishes best under very light shade, and is often found growing pure. In the Ganges Division it is found in the lower hills on damp, shady localities as well as on the more arid southern slopes, and on the flat, waterless tract below the foot-hills, known locally as the "bhabar".

The rhizome receives its chief food-supply through the agency of the leaves, and hence it is essential for the full development of the rhizome that a certain amount of leaf-surface should be left after each cutting, but under the present cutting rules this result is not always attained, especially in the more accessible forests where in some cases the contractors remove all the culms except those of the year, and as these latter do not fully develope their leaves till the beginning of the hot weather, the nourishment of the rhizomes may be checked for several months, during which period they must depend on the reserve material which they themselves contain. It is chiefly this evil which has given rise to the complaints of over-cutting for many years. The suggestion made from time to time to reduce the intensity of working have generally consisted of attempts to induce the contractors to leave a certain number of mature stems in each clump, either by ordering them to leave three or four mature stems (besides those of the year), or by ordering them to cut no stems under two years of age. It was found, however, quite impossible to enforce any such restrictions.

It must be borne in mind that there are from thirty to forty contractors working in these forests every year and each employs several scores of cutters, while the aggregate of the annual coupes varies in area from 96,000 acres to 104,600 acres, so that it is a physical impossibility to check the cutting of each of the clumps over such a large tract. The rule for not cutting culms under two years of age seems to be futile, as a two-year old stem cannot with certainty be distinguished from one which is three (or more) years old. Only the culms of the year have distinctive physical characteristics by which they can be identified at sight.

Complaints have from time to time been made by inspecting officers that the bamboo forests of this division are being far too

heavily worked and that the size of individual culms has much decreased and the reproductive power of the root-system has been greatly diminished, but so far no attempt appears to have been made to justify these assertions. It is, of course, impossible to prove that the culms of the present time are smaller than the stems of thirty years ago, except by inference from the large size to which culms attain in the more remote and less heavily worked forests, but the question of the reproductive power of the clumps can be tested by comparing the out-turn at the present time with the figures of former years. The earliest period for which reliable figures can be obtained is the quinquennial period 1880-81 to 1884-85, and the two subjoined statements give the out-turn and revenue during three quinquennial periods.

STATEMENT I.

Out-turn and revenue from bamboos for the five years 1880-81 *to* 1884-85.

Five-year period.	Number of bamboos exported.	Revenue.	Average revenue per score of bamboo.
	No.	Rs.	a. p.
1880-81 to 1884-85 ...	44,812,000	1,64,918	1 2
Average per annum ...	8,962,400	32,983	...

Note.—The above figures are taken from Mr. Hearles' Working Plan of the Ganges Division (1887).

STATEMENT II.

Out-turn and revenue from bamboos during the last ten years.

Five-year period.	No. of bamboos exported.		Revenue.		Average revenue per score.
	Total.	Average per annum.	Total.	Average per annum.	
	No.	No.	Rs.	Rs.	a. p.
1899-00 to 1903-04	50,853,201	10,170,640	4,65,612	93,122	2 11
1904-05 to 1908-09	46,101,269	9,220,254	5,92,421	1,18,484	4 1
Average per annum	...	9,695,447	...	1,05,803	...

It will be seen from these statements that, during the last ten years, the average annual out-turn is nearly three-quarters of a million better and the revenue three times as high as in the five-year period 1880-81 to 1884-85. No definite conclusion can, however, be drawn from these figures, as it is highly probable that with an increased demand and greater facility for export, contractors have gone much further afield for their bamboos, and are now working forests which were considered too remote and inaccessible in former times.

Judging from the present state of the clumps in the more accessible forests, it seems probable that the production of culms has diminished, and consequently it is high time to consider whether means cannot be devised for increasing the productive power of the crop. As regards the respective merits of the two-year and three-year rotation, it is too early yet to draw any reliable conclusion from the results of the latter system which has only been in operation for the last five years, but the following comparative statement gives the results as shown by the working of seven coupes which were formerly worked on the two-year rotation, but have been on the three-year rotation since 1904-05.

Comparative statement out-turn and revenue from bamboo blocks when worked on a two-year and three-year rotation.

Block.	ON TWO-YEAR ROTATION.				ON THREE-YEAR ROTATION, 1907-08.	
	1902-03.		1904-05.			
	Out-turn.	Revenue.	Out-turn.	Revenue.	Out-turn.	Revenue.
	Nos.	Rs.	Nos.	Rs.	Nos.	Rs.
Kunaun 1—4 ...	784,147	9,566	338,378	5,354	1,086,787	13,044
Dogadda 2, 3 ...	559,002	5,974	330,984	3,733	787,550	9,469
Shampur ...	348,901	3,113	355,482	3,158	453,407	6,483
Peli	437,901	4,358	386,103	4,863	776,031	9,494
Sukhrou & Sattikhal	874,046	10,306	923,670	14,928	1,337,150	17,310
Lalpani ...	506,091	4,718	614,605	7,778	702,569	10,069
Pakhrou ...	213,271	2,434	279,933	3,191	377,742	4,892
Total ...	3,723,359	40,469	3,229,155	43,015	5,521,236	70,761

This shows that the average annual out-turn from these seven coupes during the last two cuttings on the two-year rotation was 3,476,257 bamboos and the revenue Rs. 41,742 against an out-turn of 5,521,236 bamboos and a revenue of Rs. 70,761 when the same blocks were worked on a three-year rotation. Judging from these figures, it would appear that the annual production from these coupes under the two-year rotation was 1,738,129 culms, while during the three-year rotation it rose to 1,840,412, showing an increase of 5·8 per cent in favour of the longer rotation. All the returns, however, show that the out-turn and revenue during the year 1907-08 were abnormally high, and moreover the three-year rotation has only been recently introduced, and hence it would be premature to draw final conclusions from the above figures; but after making all allowance it appears reasonable to assume that the three-year rotation will give favourable results both as regards out-turn and revenue in the more accessible and heavily-worked forests. In the case of the more remote forests, however, the circumstances are very different, as contractors only remove the best and most valuable kinds of bamboos from these distant tracts, from whence the cost of export is so high that the charges on the smaller and thinner bamboos come to more than their market value. In order to test the reproductive powers of bamboos worked on a three-year rotation as compared with those worked on a two-year rotation, enumerations have been made of 100 clumps in different blocks with the following results:—

Enumeration of 100 *clumps in coupes worked on a three-year rotation.*

Block.	Last year of working.	No. of culms of previous years.	No. of culms of 1909.	Total No. of culms in 100 clumps.
Lalpani ...	1907-08	948	759	1,707
Sattikhal ...	1907-08	332	251	583

The forests of the Lalpani Block consist of low hills with very gentle gradients abundantly watered and with good soil and northern aspect, while the Sattikhal Block has a general southern aspect, and the hills are steeper and more arid and the soil poor; thus the production of new culms per clump in the year 1909 varies from 2·51 in Sattikhal to 7·59 in Lalpani.

Enumeration of 100 *clumps in coupes worked on a two-year rotation.*

Block.	Last year of working.	No. of culms of previous years.	No. of culms of 1909.	Total No. of culms in 100 clumps.
South Kohtri, 16 & 17	1908-09	845	435	1,280
Ditto 19 ...	1908-09	594	393	987
Ditto 5 & 6...	1908-09	583	287	870

In these coupes the production of new culms varies from 2·87 per clump in South Kohtri 5 and 6, to 4·35 in South Kohtri 16 and 17.

No definite conclusion can be drawn from these isolated experimental enumerations, but if these (or similar) experiments are continued in the Ganges Division, and made in other divisions for a number of years, it is probable that very useful deductions may be arrived at. Besides the question of intensity of felling there are two other points in connection with the sylviculture of bamboos which demand greater attention and more careful study than appears hitherto to have been devoted to them, *viz.*—

(*a*) The low-cutting of culms.

(*b*) The increasing density of over-head leaf cover, due to the vigorous growth of trees and shrubs under the beneficial effect of fire-conservancy.

The rule that bamboos should not be cut higher than one foot above ground level was introduced many years by an officer of great experience, but the reason for its introduction seems to be doubtful, unless it was on account of the difficulty in working the congested clumps of the Dehra Dun and Saharanpur forests if

high stumps were left in these already tangled masses. In the Dehra Dun and Saharanpur forests "congested clumps" would appear to be the rule and open clumps the exception, and hence it was natural for the officer responsible for the working of the bamboo forests of these districts to insist that high stumps should not be left in these congested clumps, as these would tend to make the clumps still more unworkable. In the Ganges Division, however, congested clumps are the rare exception and these occur chiefly below the foot-hills, in forests near cultivation or close to the railway. In the hill forests of this division the clumps are open, even in places where (for want of proper supervision) high stumps have been left.

Many years have passed since the introduction of the rule about lowcutting, and during that time considerable additional information has been gained regarding the growth and requirements of bamboos, and consequently it does not seem out of place to discuss the question more fully.

In an article in the *Indian Forester* of September 1900, Mr. W. H. Lovegrove made the following remarks :—"The bamboo stump, when free of branches, dies down to the ground at the general rate of one internode per annum, the death being caused by the percolation of water. The presence of these high green stumps keeps the root-system below alive, but unless they bear severa strong branches, the new culms produced are not as thick as might be, and are often mere whips."

Again, in the forest journal of the Ganges Division for the year 1900, the following note is recorded :—"The bamboo-cutting rule regarding the cutting within one foot of the ground has been very fairly enforced since 1898-99. The result is that a good deal of the surface of the rhizome is killed, there being no over-head green shoots to keep it alive."

It is a very noticeable fact that congested clumps are found in forests which are near large centres of demand, and within easy reach of railways or rivers, and where the soil is extremely poor and dry. On rich and fairly moist soil bamboos attain large dimensions and are chiefly hollow, while on poor, arid soil the

stems are thin and solid, and are known popularly as "male" bamboos. An inspection of these large tracts shows that the clumps have been reduced to this abnormal condition by continued ill-treatment of some description, while a careful examination of the individual clumps shows that the outer rhizomes have lost their reproductive power (either wholly or partially) and that reproduction has been carried on by the older rhizomes in the centre of the clump, with the result that the clump is a tangled mass of stems, while the active rhizomes in the centre (being unable to expand laterally) are pushed upwards and often form a mound 1½ to 2 feet high above ground level. The question now arises as to what description of ill-treatment has reduced the clumps over large areas to such a hopeless condition. The usual answer to this question is that congestion has been caused by continued heavy working and the leaving of high stumps, but this reply is far from convincing.

First, the leaving of high stumps could not possibly cause the death of the outer rhizomes, but would, on the contrary, prolong their vitality.

Secondly, continued heavy cutting in the bamboo forests of the Ganges Division during the last thirty years has not produced general congestion, such as is to be seen in the neighbouring Garhwal bhabar, and also in the Dehra Dun forests.

To throw some light on this difficult question, it must be remembered that the stump of the bamboo dies down at the rate of one internode per annum and consequently if four internodes are left death does not reach the rhizome for four years, and by that time it has retained sufficient vitality to throw out other rhizomes, and the *outward* expansion of the clump continues. On the other hand, if the shoots along the outer periphery of the clump are cut low, leaving only one or two internodes, death reaches the surface of the rhizomes either the same or the next year, and if this course is continued for some years, the rhizomes all along the outer periphery of the clump will be killed and these will no longer have the power of expanding outwards, with the result that the productive forces are confined to the older

rhizomes inside the clumps, and thenceforward culms will be given out from the interior of the clump and produce " congestion ".

An examination of a large number of roots of congested clumps in the Garhwal bhabar showed that this has actually occurred, and the outer periphery for a width of 9 inches to one foot consisted of a mass of dead rhizomes.

The method, known locally as "jar-khod" (*i.e.*, root-digging), of obtaining walking-sticks and sold bamboos for various purposes, is undoubtedly responsible to a very large extent for the production of congested clumps, especially in forests near large towns like Dehra Dun and Hardwar, where the demand for solid bamboo walking-sticks is very great. This method consists, as the local name implies, of either extracting the rhizome with the bamboo, or cutting the shoot just below ground level so as to obtain a solid butt end.

There seems little doubt that the lower the bamboos are cut the greater is the damage done to the root-system, and hence low-cutting should be discouraged.

Heavy over-head leaf cover.—Since the introduction of fire-conservancy there has been enormous improvement in the general forest growth, and the bamboo clumps are being heavily shaded, chiefly by trees of the miscellaneous species. The bamboo requires only a moderate amount of shade, and hence a judicious thinning out of inferior trees which overtop the clumps would greatly benefit the bamboos.

METHOD OF EXPORT OF BAMBOOS.

The bamboo blocks of the Ganges Division are sold on the "monopoly and royalty" system by auction at Najibabad at the end of September each year, so as to allow the contractors ample time to make their arrangements for cutting and export before work is begun in November.

At the sales the sole right to cut and export bamboos from each coupe is put up to auction, and the amount thus obtained is called the "monopoly-money". As each coupe is disposed of, the purchaser is required to deposit 10 per cent on the monopoly-money as security deposit, and to sign a printed agreement deed.

The monopoly-money must be paid in three equal instalments which fall due on the 1st December (or earlier, if work is begun before that date), 16th January and 1st March.

The export of bamboos takes place from what are known as "export choukis," which are usually situated along the forest boundary, and here the purchaser has to pay royalty on each consignment. Before export is permitted the purchaser must deposit small sums as "advance revenue" in any Government treasury or to the range officer of the range in which he is working. For these payments of "advance revenue" the purchaser receives a receipt from the treasury which he sends to the range officer, who informs the moharrir at the export chouki of the amount of the advance revenue and orders him to pass out bamboos up to this amount. If the purchaser intends to export through more than one export chouki, he must pay advance revenue for each chouki, and thus the export returns of each chouki are kept separate. The purchaser is then at liberty to begin the export of his bamboos.

Whenever a consignment arrives at a chouki, the moharrir counts the number of bamboos of the various classes, and then makes out a "rawanna" or pass on which are given all the details of the consignment, and the number of bamboos of each class and their royalty rates, and at the end is shown the total royalty of the consignment, while in the remarks column of the rawanna is shown the amount of advance revenue in the purchaser's favour and from this is deducted the royalty due on the consignment, and then is struck the balance of advance revenue (if any) still left to the contractor's credit. This balance is carried forward to the next rawanna, so that the purchaser knows exactly how his account stands after the issue of each rawanna, and when the advance revenue is nearly exhausted, he pays in a further sum as advance revenue and so continues till the whole of his bamboos have been exported. This system of revenue collection is known as the "monopoly and royalty system."

Some miles below the line of export choukis is another line of what are known as "check choukis," and all produce which has

passed out of the export choukis is checked finally, and passed out from these check choukis. After having made out all the details of the produce as already described, the export moharrir enters the name of the check chouki at which the consignment has to be checked and keeps a different serial number for each check chouki. He also enters the hour of issue of his rawanna and the latest date and hour by which it must pass the check chouki. He then makes out a duplicate of this rawanna which is handed over to the purchaser or his agent and the consignment can then proceed on its way to the check chouki mentioned on the rawanna. The export moharrir then enters an abstract of the transaction in double entry in a separate ledger account known as the "chalta hisab," a separate book being kept for each purchaser, who can inspect his account whenever he likes. Every evening the export moharrir prepares a detailed list of all rawannas issued during the day in a printed form known as the "roz marrah," and these are sent every morning by the regular chouki-dâk to the divisional office where they are checked.

On arrival at the check chouki the man in charge of the consignment hands his duplicate rawanna over to the check moharrir whose first duty is to see that the serial number for his chouki is correct, to ensure that no consignment has been taken down country without first having passd his chouki. Thus suppose, for instance, that the last rawanna which he received was numbered 41 and the next one presented to him was numbered 43, he would know that the consignment covered by rawanna No. 42 had been taken away without his having checked it. The moharrir must in such a case report the number of the missing rawanna to the range officer and the check officer, who will make the necessary enquiries and apprehend the offender.

The next duty of the check moharrir is to compare the number of each class of produce with the entries on the rawanna and note any difference in red ink. He must then check all the calculations on the rawanna and see that all the entries are correct. After doing this he retains the duplicate rawanna, which is sent to the divisional office, and issues an

abstract called "mussanah" and the purchaser is then free to take away his produce.

If on checking any discrepancy is discovered in the amount of produce, the purchaser is liable to be fined ten times the amount of the value of such extra produce. The whole of this work is checked by a senior ranger who is continually moving along the line of choukis.

Wherever the nature of the ground is favourable, the forests are provided with good cart-roads along which bamboos are exported by carts. The export from the hill forests is managed by having the bamboos dragged out by buffaloes and bullocks and brought to convenient camping grounds, or depôts, near a cart-road. The dragging animals are provided with thick pads of *Ischæmum angustifolium* grass to prevent their flanks being rubbed, and the bamboos are made into two bundles, one of which is lashed on either flank of the animal, the butt ends being uppermost and the thin ends dragging on the ground. Though this is a primitive method, it answers the purpose well ; there is no weight on the back of the animal and consequently no chance of its suffering from sore-back.

Water-borne bamboos are most highly prized in the plains markets, the two rivers down which they are taken being the Ramganga and the Ganges.

UTILISATION AND CLASSIFICATION OF BAMBOOS.

The chief use of bamboos is for roofing purposes where they supply the place of ridge-poles, rafters and battens. A large quantity of the better kinds of bamboos is used in the construction of tents, while there is a large demand for solid bamboos for walking-sticks and lance staves. The bamboo furniture made at Bareilly is well known in the United Provinces. and this industry takes up a fair number of bamboos. They are also used largely for the manufacture of chicks, chairs, baskets and a variety of articles of domestic use.

Dealers in bamboos, both local and foreign, have special technical names for the different classes of bamboos, the chief of which are the following : —

1. *Laggi.*—These are hollow bamboos, from 18 to 20 feet long, and are used chiefly as poles for rafting and as supports for dovecots. The export of this class is very limited.

2. *Charhao.*—These are solid at the butt end, being cut as near as possible to the ground level, about 15 feet in length and from 9 to 12 inches in girth, and are used as rafters, ridge-poles, tent poles, ladders and poles of carts. There is usually a large demand for this class of bamboo from the Punjab.

3. *Sarencha.*—This is the kind most largely exported. Sarenchas are cut in two lengths known in the market as a "chougazi sarencha," and "pach-gazi sarencha," *i.e.*, 4-yard and 5-yard sarenchas. They are hollow and are used almost entirely for roofing purposes. The thinner sarenchas are used for making bamboo furniture.

4. *Bahi.*—These are solid at the butt end, 6 or 7 feet long, and are used entirely for making charpoys, or cots; in the retail market they are sold in threes, two being used for the sides and one, cut into 2 pieces, for the ends of the charpoy.

5. *Chhar.*—These are solid thin bamboos, varying from 12 to 15 feet in length, and are used as spear and lance shafts, poles of small tents, rafters of small houses and for flooring the bottoms of carts.

6. *Kanderu.*—These are thin bamboos, solid at the butt end, but hollow at the top, from 8 to 10 feet long, and are used chiefly for kanats of tents and for roofing the houses of the poorer classes who cannot afford to buy sarenchas. The side branches of kanderus are lopped with two strokes, one from below upwards and the other from above downwards, thus giving a clean surface to the part cut.

7. *Channeju.*—The chief difference between chhanejus and kanderus is that the former may be hollow at the butt end, and the side branches are lopped off with one blow only of the axe from above downwards which tears off a portion of the skin below the cut. In length and thickness they are similar to kanderus. Chhanejus are usually obtained from the toppings of sarenchas, whereas kanderus are cut from the lower part of thin culms.

8. *Lathi.*—These are solid bamboos up to 6 feet in length and are used as walking-sticks.

9. *Bansuli.*—These are thin, very straight, hollow bamboos, with long internodes, and are used for making flutes and the stems of huqqas.

10. *Khunta.*—Short butt ends, up to 3 feet in length, used as pegs.

Like all technical trade names these various classes are well known and thoroughly understood by all bamboo merchants and oth r persons interested in the bamboo trade, and there is no mo e fear of one class being confounded with another than there is of a wheel-wright or carpenter mistaking a felloe for a spoke of a cart-wheel.

In the price list at present in force in the Ganges Division, royalty on bamboos is charged for according to their length, without regard to their thickness or the purposes for which they are used, and without regard to the ruling market rates for the various kinds of bamboos.

Advantage is taken by the local contractors of the present system of rates in various ways, which will be better explained after a perusal of the two following statements, the first of which shows the present royalty rates, and the other the trade classification and selling rates of bamboos :—

Abstract from the price list of 1909-10.

Class.		Length.		Girth.	Rates. Per	Rates. Ganges Division.
						a. p.
Hollow.	I	above 20 feet	...	Any	each	1 0
	II	16 to 20 ,,	...	,,	,,	0 8
	III	13 ,, 15 ,,	...	,,	score	3 0
	IV	5 ,, 12 ,,	...	,,	,,	2 0
	V	1 ,, 4 ,,	...	,,	,,	0 9
Solid.	VI	1 ,, 7 ,,	...	,,	,,	1 9 Bahis.
	VI	1 ,, 7 ,,	...	,,	,,	4 0 Lathis (jarkhod).
	VII	8 ,, 12 ,,	...	,,	,,	3 0
	VIII	over 12 ,,	...	,,	,,	at hollow rates

Local classification and selling rates of bamboos.

Market name.	Length.	Selling rate at Najibabad.
Laggi	16 to 20 feet ...	Rs. 0-12-0 to Rs. 1-0-0 each.
Charhao	15 feet	" 12-0-0 to " 15-0-0 per score
Sarencha pach-gazi ...	15 "	" 2-0-0 per score.
Do. chou-gazi ...	12 "	" 1-0-0 to Rs. 1-4-0 per score.
Bahi	7 "	" 1-4-0 to " 1-8-0 "
Chhar	12 to 15 feet ...	" 5-0-0 to " 8-0-0 "
Kanderu	10 feet	" 1-8-0 per score.
Chhaneju	10 "	" 0-10-0 to Rs. 0-12-0 per score.
Lathi	6 "	Fancy rates.
Bansuli	8 to 10 feet ...	Do.
Khunta	3 feet	Rs. 0-6-0 per score.

It will be seen that the charhao, which is the most valuable kind of bamboo (leaving laggis out of the question) can be brought down to 12 and 15 feet and thus come under class VIII of the official classification, and the royalty charged on it will be the same as for sarenchas of the same length, but which are not nearly so high-priced in the market. Again, the chhar if cut more than 12 feet long, would also come under class VIII.

There appears to be no advantage in continuing the present official classification, whereas the adoption of the local nomencla ture and a revision of the rates for the different kinds of bamboos fixed in proper proportion to their market value, would probably give a better revenue and would greatly simplify the export and checking work. Another advantage of adopting the local nomenclature would be that if it were found that any particular coupe was being too heavily worked and that more culms should be left in each clump to supply the necessary leaf-surface, an executive order could be issued prohibiting the cutting and export of any particular kind (or kinds) of bamboo, such, for instance, as

kanderus or chhars. Such an order could be enforced at once, as any breach of it would be detected as soon as the bamboos were brought into the depôts, whereas it has been shown above that a general order to leave a certain number of culms in each clump cannot possibly be enforced.

SUGGESTIONS FOR FUTURE MANAGEMENT.

The following suggestions are offered with a view to mitigate some of the havoc which has been done in the past and to improve the general condition of the bamboo forests of the Ganges Division:—

1. The three-year rotation might with advantage be extended to some of the blocks which are at present being worked in alternate years, and from which the thinner classes of bamboos are being exported. The more remote blocks, from which only large-sized bamboos are cut, could be continued on the two-year rotation.

2. A systematic thinning and weeding of trees of the inferior species, or unpromising stems of the better kinds, which are overshading bamboo clumps should be begun as soon as possible.

3. The royalty rates list should be revised and the local nomenclature be adopted for classifying bamboos.

4. In blocks which are noticed to be overworked, the extraction of the thinner classes of bamboos should either be reduced or totally prohibited. It has been shown that such an order could be easily enforced if the local classification of bamboos were adopted, and by leaving the thinner classes of bamboos a sufficiency of leaf surface would remain for the nourishment of the clumps.

5. The one-foot cutting rule should be abolished, and low-cutting be discouraged. This suggestion does not apply to forests which contain a large percentage of congested clumps.

6. The cutting below ground-level of male bamboos should be prohibited. There is a great demand for solid bamboo sticks, and it has been shown that these are most common where the soil is poor and arid, and the forests from which such bamboos are obtainable are well known. If then it is considered necessary

that a certain quantity of bamboo sticks must be given annually, the cutting of these should only be allowed once in six years in any particular block and this restriction would minimize the injury done to the clumps.

B. A. REBSCH.

CORRESPONDENCE

SHIKAR, TRAVEL, AND NATURAL HISTORY NOTES.

THE BISON OF THE SATPURAS.

The bison is, I think, the hardest earned of all trophies, for though, of course, the tiger may be the king of the jungle, he is plentiful and not very hard to bag—especially over a kill. Bison, on the other hand, are scarce and extremely difficult to get, at least they proved so in our district of the Central Provinces, and though we heard them occasionally on the hills, I only once got a sight of one.

On many occasions I organised beats in the hopes of bagging bison, but never succeeded in catching them in the beat, except on one occasion, and then the beaters muddled it, as is generally the case, and the herd of about five head broke back. I did however at last succeed in bagging a fine bull, shortly before I left the Central Provinces, but it was a great stroke of luck and I had no idea of meeting bison that morning.

It happened thus. I was out for a few days' holiday in December 1904, my camp being pitched close to the village of H. I had chosen this spot, as there is a considerable amount of malguzari jungle surrounding it, and as I was only out for a short period, I had not applied for a permit to shoot in the Government reserves. One night I heard some sambhar calling on one of the hills, and so decided to try my luck at stalking, in the hopes of securing a good head. Accordingly, about 5 A.M. the next morning, I got up and taking my ·500 Express, and my shikari, Abdul, we started off. It was bitterly cold, and it had been freezing during the night, and must still have been freezing when we started; there was a small waning moon, being the last quarter. My plan was to get up to the top of the hill before dawn, as the sambhar generally make for the summit at dawn, and rest there during the day time, descending again in the night to feed on the crops in the fields. It sounds easy enough on paper, but in reality it

was a very stiff job, what with the cold and the bad light, to say nothing of the long grass which was wringing wet with the dew, reaching up to our chests; and to make matters worse it was spear grass. I was not so badly off, having on thick khaki cord breeches, and a stout drill coat, but the unfortunate Abdul, though he had on a drill coat, had only thin cotton pyjamas over his nether limbs, and must have suffered considerably. About half way up the hill I nearly walked on top of a sambhar doe, which got up with a bell, and rushed off up hill, where it stood belling for a short time, and then cleared away. This did not look very promising for us, however we kept on and finally reached the summit. This we found, as is often the case, was almost bare, with very short grass, and only a few trees. As it was not yet dawn we had to wait for about a quarter of an hour, so sitting down under a tree we tried to make the best of things; though even the luxury of a smoke was denied us. After about 5 minutes' wait we heard something coming up the hillside, on the opposite side to which we had come, and though it was some distance off, we concluded it was a sambhar, so sat still and waited. Presently the day began to dawn, and as the animal was now nearer the summit, and there was nearly enough light to shoot by, we made our way cautiously along the top to a point which we thought was nearest to where the animal was grazing. Arriving there we concealed ourselves behind a bush, and were delighted to hear footsteps coming in our direction. Our hopes were soon dashed to the ground however, as instead of coming to the grassy plateau on top, as we had hoped he would, the animal turned off at right angles and began moving away from us along the side of the hill. By this time it was fairly light, and we followed along the top, as well as we could, guided by the noise he was making. All of a sudden the sound ceased, and we waited breathlessly, fearing that he had scented us, and would make off in another direction. For fully five minutes we waited, and then we heard footsteps again, and this time coming towards the top. There happened to be a small nullah with bare stones running down the side of the hill, close to where we were stationed, and the animal was heading for this.

Accordingly we crept along for a little distance and took up our position behind a stunted teak tree, which commanded a fine view of the nullah. The animal approached steadily and we heard him step into the nullah, and the sound of his hoofs on the stones, and then to our delight we heard him coming towards us up the nullah. About 50 yards down there was a bend beyond which we could not see. I got ready, though my hands were so cold I could hardly raise the hammers. Slowly, slowly, the footsteps approached, and then round the bend there appeared, not as we had expected a sambhar, but a large bull bison. For a second I was too surprised to do anything, and then I raised my rifle to fire. That one second's pause spoilt everything, for he had spied us, and wheeled about to run. I managed to get in a hurried shot, and hit him, for he staggered perceptibly. There was no time for a second shot and we heard him crashing down the hillside at a terrible pace, into a large valley, which was at the base of the hill dividing it from another even higher hill than the one we were on. When he reached the valley, we did not hear him any more.

Abdul and I then held a consultation as to the best plan to adopt, whether to follow up the bison at once, or return and have breakfast and bring more men to help us, and if necessary to organise a beat, for I scarcely thought that he was mortally wounded. We decided on the former, so descending into the nullah we examined the spot where he had stood when I fired at him. There were one or two spots of blood on the stones, and we thought he was only hit slightly, but on proceeding a little further we were pleased to see that he had been bleeding profusely, and that the blood was bright red in colour, so that we knew he was badly hit. However, it is no joke following a wounded bison in long grass, and we proceeded very cautiously when we reached the valley. Here he had evidently stood for a short time, for under a teak tree there was a small pool of blood, and the tree itself was smeared in one place where he had evidently brushed against it. The spoor led us for some distance along the bottom of the valley, there the grass was about waist deep, and the up

the side of the opposite hill. The blood drops were less frequent now, though the spoor was easy enough to follow, as the grass was all bent and trodden down where he had passed. A little way up the side of the hill, he had sat down for a short while for the grass was all beaten down, and plentifully smeared with blood, but he had evidently not remained long, as we had followed pretty hard on his tracks, but I thought we were getting close to him and kept an extra sharp look out in consequence remembering that he was above us, and in all probability, unless *hors de combat*, would charge us on sight. We proceeded very cautiously for a short distance further, and then what I feared happened. Without the slightest warning the bison jumped up from the long grass ahead of us, and charged down on us like a flash. I fired both barrels simultaneously into his chest at about 20 yards' distance, the recoil very nearly knocking me head over heels: as it was I fell but managed to fling myself sideways into the long grass, and felt the bison go crashing past within a couple of yards of me. How Abdul escaped I do not know. I was fully occupied with reloading as soon as I knew the bison had passed me, for I expected him to return to the attack. It was, however, his final effort, the two bullets in his chest taking effect, he rushed down the hill for about 50 yards and then fell with a terrific thud, and with a few kicks died. I afterwards learned that Abdul had escaped in much the same way as myself; as soon as he saw the bison charging, he jumped aside, and to use his own expression, "dubbed down in the grass till the danger was over". Though had my shots not taken effect, I am afraid things might have ended rather seriously for us. We went down to where the bison was lying, and found him quite dead. My first shot had hit him in the side and penetrated his lungs, the last two fired simultaneously hit him in the left breast and entered his heart.

It was now about 10 o'clock and we were stranded in the middle of a thick jungle, with a large bull bison to get back to camp, to say nothing of our having had no food or smoke, with the prospects of a stiff climb up the hill again before we could reach the tents. However I was so pleased over the bison that

I forgot all discomforts and having cut down some boughs and covered him up as best we could, we set off on our homeward tramp; we arrived at length, and had our much needed breakfast. Needless to say there was great rejoicing in camp and also in the adjacent village among the beef-eating community, though those whose caste forbade them to eat, did not show so much excitement.

After breakfast, and a short rest, we returned with a regular army, and, of course, had to skin the bison in the jungle.

The head I sent on to camp as soon as possible, in the charge of one of my own men. We skinned the rest of it, and returned to camp by about 4 P.M. thoroughly tired out but happy. I, because I had bagged my bison, Abdul, because the *huzoor* had had good luck, and the villagers, because they had as much meat each as they could carry to eat.—(*By Up-Country in the Indian Field.*)

A MODEL TIGER BEAT.

There is an entry in my shooting diary which always attracts my attention. We were out tiger shooting one cold day, and had had a run of bad luck. In spite of the most careful arrangements and the services of the very best shikaris, things had always gone wrong at the critical moment. Some one blundered, the stops let the tiger pass, the beaters lost their cohesion, and let him break back; everything that possibly could go wrong did go wrong, and on the day of which I write we had been out all day and drawn blank. There was just one more chance, and two hours of daylight remaining. During the night a pair of tigers had killed a buffalo, which we had tied up in some splendid jungle about four miles from camp.

Our camp was pitched in a wide valley, the western boundary of which is formed by a range of high hills clothed from summit to base with dense jungle and foliage of ever-varying tints, the harmonious combination of hill and wood, rugged, steep, and shady dell, making an exquisite picture to delight the eye of the sports-

man or artist. Along the lower slopes and among the foothills of this range was the home of the pair of tigers we were now hunting. The beat would start near the road, and work along a broken ridge toward the guns placed a mile or more further on.

The sun is slanting towards the west as we climb into our trees, and there is no time to waste. We take a last pull at our water-bottles (hot work this tree climbing at four o'clock in the afternoon!), look a dozen times to rifles and ammunition, settle down comfortably, and test our ability to cover every possible line of approach and then the beat is heard in the far distance. Keep still now, with every sense on the alert: jungle creatures have a wonderful facility for appearing suddenly without warning. Your eyes may be fixed on some spot where you expect the tiger to come from, when, with a start, you realise that he has arrived; but how on earth he got there without your noticing his approach beats you.

Almost simultaneously with the commencement of the beat we heard "Ponk, ponk!" the bell of frightened sambhur. That was good hearing; the tigers were moving, to a moral certainty. Presently three hinds and several fawns appeared under my tree—no stag with them. He was probably away by himself in the high hills. They passed by, and were swallowed up in the jungle. A short interval and then away down the hill on the left, beyond C., was heard "Tap, tap, tap." The tiger trying to break out has been turned by a stop. And how one's heart beats at the sound! One is suddenly conscious of several possible lines the tiger may take, which one cannot possibly cover. What an impossibly thick piece of jungle to shoot in! There's plenty of excuse for missing here, but imagine the head shikari's face at hearing of a tiger missed! What a freezing picture of ill-concealed contempt and disgust! And then C., too. Good Heavens! no, there must be no question of missing.

You pull yourself together as "Click, click!" comes from your right front. The Gond in the very tree I relinquished in favour of the one I am sitting in has stopped the tiger. Then perfect stillness again, till far down below me, between C.'s tree and mine, gliding through the long grass, was the striped back and lithe form

of a tiger. As I swung round to my left to prepare for a shot C. fired, and, without the familiar "Woof! woof!" of the wounded tiger, the great brute darted forward, a streak of yellow and white light. I covered him, pulled as he appeared for a moment between two trees, and before I could recover or take note of the result of my shot he had disappeared behind a bush.

Perhaps five minutes passed or it may have been fifteen—one does not note the passage of time on these occasions—when the stop on my right was again busy. Then silence, broken at last by a heavy footfall among the litter of dead leaves and twigs. One cannot help turning in the direction, though it is certain no tiger ever made a noise like that. Strutting along is that gaudy piece of conceit, a peacock in full plumage, one of the noisiest walkers in the whole jungle. Again the stop on my right is at work, and suddenly, with a snarling growl, the tiger bounds down the hill, crashing through thicket and bamboo, only fifty yards in front of me, but completely hidden from view. Then all is silence again till a single shot rings out from below. No sound follows, so No. 2 is probably dead, for C. does not often miss.

The beat is practically over now; the beaters have only another 100 yards to go. An old grey langoor monkey, bounding from one tree to another, running a few yards, stopping to look round, quite undecided what his next move would be, arrived all unsuspecting at the spot where No. 1 had fallen. The startling discovery fairly electrified him, and away he went *ventre-a-terre*, running for his life, a most ridiculous picture of terror in full flight. My word, what a hurry he was in! His movements had told me that, dead or wounded, the first tiger was lying somewhere near that bush. So the beat was stopped, and the elephant called up. C. dropped into the howdah from his tree, and with the shikari advanced slowly towards the bush. A loud "Whoo-oop!" announced that the tiger was dead. Good business! I swarmed down my tree without waiting for the ladder. How glad one is after a long tiger beat to get down from the perch one has been in for an hour and a half. What a relief to stretch one's cramped limbs. And with what delight does one examine the dead tigers.

There they were, a huge male tiger and tigress in perfect condition. Magnificent trophies both of them. Although I have before seen two, and even three tigers shot in a single beat, I always look upon the one here described as a pattern of what a tiger beat should be.—(*By X. in the "Field"*.)

PROTECTIVE GOLOURATION.

In a very interesting and instructive article,* entitled "Protective Colouring in Animals," which appeared in the *Indian Field*, dated 1st April, the writer gives some very graphic accounts, showing the utility of protective colouration in insects, birds and mammals.

Among many instances in wild life, such as butterflies which, when sitting among leaves, are invisible to the closest observer, he cites, as examples, Mr. Thayer's well-known models of the visible and invisible ducks in the Natural History Museum, which very conclusively prove the benefits derived to the bird that is protectively coloured.

While in no way disparaging the theory of protective colouration, any one who has spent some time in the jungles of India, for instance, is inclined to pause before accepting, as so many do, that protective colouration is the only factor, except, perhaps, natural selection, that birds and beasts have to rely on in the great struggle for existence. What other agencies play a part, we shall, perhaps, in time learn, but that there are others, there can be no doubt, or how else can one account for the myriads of gaudily coloured finches, flycatchers, orioles, grosbeaks, etc., that one finds so prolific in India and which appear to find the great struggle none too terrible, if the numbers which survive it, be any criterion. Taking it for granted that both protective colouration and natural selection are at any rate the chief factors, which we have to thank for keeping alive so many of our little friends, one naturally asks the question, why should only certain kinds benefit from protective colouration and a limited few learn by experience, how and where

* Reproduced on p. 649 of Vol. XXXV of the *Indian Forester*.

to build, to escape the ravages of predaceous birds, while hosts of feeble little birds, having benefited by neither, are left out in the cold?

Strangely enough those which have learnt the lessons of natural selection, are the very ones which least need their advantages as I pointed out in an article in the *Pioneer* some years ago.

Kingfishers, hoopoes, rollers, bee-eaters are among those which build in holes, because, as it has been pointed out to us, both male and female are gaudily coloured and the female would be so conspicuous while sitting on her eggs if she built in the open. So far the reason appears an excellent one, but then, why should this device be confined to such a small minority? The abovementioned are all birds well able to look after themselves. The kingfishers and rollers, besides being very strong on the wing, have a pair of mandibles to inspire respect, and as for the hoopoes and the bee-eaters, they are both past masters in the art of dodging and it takes a very smart falcon to catch either of them.

Now we find the gorgeous minivets, paradise flycatchers, orioles, grosbeaks and many others as resplendent, building an open nest in a tree. It is true that the hen, in each of the above instances, is more sombrely clad than the cock, but this makes little or no difference, when both birds take their turn at incubation, as egg thieves are not so obliging as to only come along whilst the female is sitting.

What could be more conspicuous than a cock paradise flycatcher, with his long, white, ribbon-like tail, streaming away a foot or more beyond the nest? Yet he flourishes out in the open, while a parrot, for instance, who might safely build in the open and still be invisible among green leaves, betakes himself and his powerful cutting beak, not less formidable than the hawk's which he seemingly fears, into a hole of a tree or a chimney.

In conclusion we might just consider who the egg thieves are which the birds must avoid. Hawks, falcons and the Raptores generally, we might leave out of the question almost entirely, for with the exception of the honeybuzzard, there are no regular nest hunters among them, though a marauding kite or harrier or the

Photo.-Mechl. Dept. Thomason College, Roorkee. Photo. by N. Gill.

Paradoxurus grayi.

THE HIMALAYAN PALM-CIVET.

black eagle may sometimes rob a nest. Hawks and falcons will very seldom attack a stationary object, so a sitting bird is more or less quite safe with them.

The common coucal or crow-pheasant is a notorious egg thief from which minivets and orioles are fairly safe, as they build high up in trees, whereas the coucal confines his depredations to the ground, or branches up to about 20 feet from the ground and bushes and grass, where he would naturally meet with babblers, reed-warblers and that ilk, who, by the way, are protectively coloured. The chief nest robbers, we have in India, are snakes and mongooses, and to these the protectively coloured, as well as the gaudily dressed, those that build in holes, and those that build in the open all pay toll alike, for with the exception of those birds which build on the ground, colour is of no consequence, for looking from below, the mongoose would presumably see the nest itself and not the bird inside it. This being the case, what is the use of protective colouration and natural selection? If the thousands of little ones, which are bereft of their benefits, get along so well in the world and are on an equal footing, as regards numbers with more favoured brethren, what is it that brings them through the struggle unscathed?—(*By Exile in the Indian Field.*)

THE HIMALAYAN PALM-CIVET (PARADOXURUS GRAYI.)

Through the courtesy of Mr. Norman Gill, F.L.S., Superintendent of the Kumaun Government Gardens, we are able to publish this month a good photograph (Plate 9) of the head of *Paradoxurus grayi.* The species, though recorded to be to a great extent frugivorous, is a great curse to poultry fanciers in the hills. If one does get into a fowl-house it leaves not a bird alive. It is also very destructive to the wild game birds. Vermin of this description should be destroyed whenever chance offers. It has excellent fur and its skin is well worth getting. This palm-civet is easily tameable and makes a charming pet.

EXTRACTS FROM OFFICIAL PAPERS.

CONSTITUTION AND WORK OF THE BOARD OF FORESTRY.

Government of India's Circular No. $\frac{2 F.}{177-16}$, *dated* 13*th January* 1910, *to all Local Governments and Administrations.*

In this Department's Circular No. 19 F.—177-2, dated the 19th July 1909, a proposal to constitute a Board of Forestry on the same lines as the Board of Agriculture was circulated for the consideration of all Local Governments. The proposal has been unanimously approved by the Local Governments, and the Government of India have accordingly decided to appoint a Board of Forestry to hold its first meeting in April 1910.

2. The Board will for the present be composed of the following members, provided that their services can be spared :—

(I) The Inspector-General of Forests to the Government of India ... ...*President.*

(II) A Chief Conservator or Conservator from each province where officers of this rank are stationed to be nominated by the Local Government or Administration. } *Members.*

(III) The President of the Imperial Forest Research Institute. } *Members.*

(IV) The Assistant Inspector-General of Forests,...*Secretary.*

The Governments of Madras and Bombay will each be at liberty to depute a Revenue Officer as member of the Board if they desire to do so. The Inspector-General of Forests may invite officers other than members of the Board to attend meetings and to assist the Board in its deliberations on subjects on which they may be specially qualified to advise.

3. One of the chief functions of the Board will be to advise on the management and work of the Imperial Forest Research Institute at Dehra Dun, and the Government of India trust that the constitution of the Board will serve to bring officers from all provinces into close touch with the work which is being carried on there, and

that the Institute will thus in an increasing degree command the interest and active support of the Department. The Board will also deal with any general problems connected with Forestry, whether scientific or administrative, which may be referred to it for advice. It is not intended, however, that the Board of Forestry should exercise any executive control over the Research Institute or College or the Forest Department generally or that it should in any way interfere with the functions of Local Governments. It will be a purely advisory body and will deliberate only on such questions as are specially brought before it by the Inspector-General of Forests who will, with the sanction of the Government of India, draw up a programme for its meetings.

4. Any resolutions that the Board may pass will be submitted, by the Inspector-General, to the Government of India for information and orders; and Local Governments will ordinarily be left to take any action on them which they may think necessary. In no case will action be taken by the Government of India on any recommendation of the Board until the Local Government concerned has been consulted.

5. The first meeting of the Board will be held at Dehra Dun, but it will not necessarily meet there every time, and it will be convened on each occasion at such time and place as may be fixed by the Inspector-General of Forests with the approval of the Government of India. After a time and place for holding a meeting has been fixed, the Inspector-General will make the necessary arrangements directly in consultation with Local Governments.

Inspector-General of Forest's Circular No. 1, *dated* 17*th January* 1910, *to all Chief Conservators and Conservators.*

I have the honour to inform you that a proposal to form a Board of Forestry has been approved by all Local Governments and Administrations and accepted by the Government of India, who are issuing a circular regarding the constitution of the Board and its functions.

2. It is hoped to hold the first meeting of the Board of Forestry at Dehra Dun towards the end of March or beginning

of April next, and one of the principal matters for discussion at this meeting will be the lines on which forest research should proceed. This question has been under consideration for some time, but it is one of much difficulty and of far reaching importance; it is important therefore that the opinions of the senior officers of the department should be obtained for discussion by the Board.

3. It has for some time past been realised that the position of affairs at the Imperial Forest Research Institute is unsatisfactory, inasmuch as the present rules do not lay down the duties and responsibilities of each officer with sufficient precision; and more particularly, because the collection of data for research work is almost entirely dependent on the goodwill of local forest officers, who naturally object to the extra work involved, and who are often unable to carry it out properly in addition to their already heavy ordinary duties. This, it is thought, has sometimes led to a lack of sympathy amongst forest officers, with the work that is being done at Dehra Dun.

4. It is desired to bring the department as a whole into closer touch with the work of the Institute, and to give all provinces a voice in its management and in the preparation of the programmes of work to be carried out. It is also considered advisable to make the research officers more directly responsible for the work done than has hitherto been the case, and to ensure that they should themselves conduct as many of the experiments as possible and be responsible for the necessary observations and records. Continuity in experimental work cannot, it is feared, be expected from divisional forest officers who are frequently changed.

5. It is by no means proposed that the Research Institute should be independent of assistance from local forest officers. This will never be possible nor would it be in any way desirable; rather it is desired to enlist the interest, and obtain the assistance of the Forest Department as a whole in the work of the Institute, and it is hoped that the constitution of the Board of Forestry, of which the members would be drawn from all provinces, will go far to attain this object.

6. In the hope of attaining the above objects, a set of rules for the preparation of programmes of research and for the better regulation of the duties of the officers of the Imperial Forest Research Institute has been drawn up. These rules have been discussed and approved by a Committee of Forest Officers who met at Dehra Dun in March 1909 and recommended them for adoption. The rules are capable of improvement and I would ask you to favour me with any suggestions concerning them which you may wish to offer. Before favouring me with your opinion you are at liberty to consult any officers serving under you. Any suggestions you may put forward will be placed before the Board for consideration. They should reach me therefore by the first week in March at latest.

7 A tentative triennial programme of research for the forest years 1910—1913 has also been drawn up by the President of the Research Institute, a copy of which was forwarded to you with the President's Circular No. $\frac{27}{2}$, dated the 28th October 1909. Your remarks regarding this programme should also reach the President as early in March as possible.

8. The rules and programme as modified by the Board of Forestry will require the approval of the Government of India before they can be finally adopted.

9. The Board will also be competent to discuss any practical or scientific questions connected with Forestry which, with the sanction of the Government of India, may be brought before it.

Any such subject which you would wish to bring forward for discussion by the Board should, if possible, be in the form of a printed paper or formal Resolution which should reach me early in March next.

GREEN-FLY PEST IN HIMALAYAN FORESTS.

The damage caused in the coniferous forests of Europe by a species of green-fly (*Chermes abietis*), whose punctures form cone-shaped galls, is well known. In 1892 an Indian forest officer reported that a species of the same genus formed galls on the spruce in the Himalayas. Specimens of the insect were examined by the late Mr. Buckton, who considered them identical with the European

pest. Mr. E. P. Stebbing, who has worked at the subject for several years, read a paper at the last meeting of the Linnean Society, in which he described the eastern form as a new species (*C. himalayensis*), and pointed out that the damage caused by these insects was of a serious nature. Young spruce trees were often seen loaded with galls, as many as 80 per cent of the branches bearing at times several cones apiece. Each of these cone-shaped galls meant the destruction of a bud or future branch. The growth of young silver firs was impeded by the punctures and suction of these pests. The upper portions of the new shoots were contorted, the needles on the upper half twisting round one another tightly, forming a loose kind of gall-like structure, which subsequently withered and dropped off. As many as 90 per cent of the new shoots had been observed to be corkscrewed and killed in this way.—(*The Field.*)

SOIL INOCULATION.

In view of the controversy with regard to soil inoculation which has occupied the gardening press for some considerable time, the following may be of interest. In a forest nursery in which I am personally interested large numbers of false acacia (*Robinia*) were raised for transplantation to various parts of the forest, where they were used to form under-growth and to fill up gaps. They were raised from seed sown in long narrow rows running from north to south. They grew here very well, and when they had reached a fair size they were transferred to the forest, leaving the beds free for another crop. As no other plant was needed, the beds were again sown with *Robinia*, and, quite by accident, the direction of the rows was changed to east-west, that is to say, at right angles to those of the former year. The result was astonishing. The seeds all germinated but the plants grew remarkably uneven. On examination it was plainly to be seen that those growing in the soil not crossed by the former rows were in vigorous health, whilst the others, with few exceptions, were weak and miserable. What was the cause of this? *Robinia* is one of the most easily satisfied

of plants; moreover, it enriches the poorest soils through the power of its roots to take up atmospheric nitrogen, and by virtue of the great amount of nitrogenous products contained in its leaves. And yet the second crop failed to grow in the soil which had been occupied the previous year by plants of the same kind. I might mention that previous to the second sowing a fair sprinkling of chemical manure, mainly kainit and superphosphate, was applied to the soil.—(*J. G. in the Field.*)

FORESTRY AT OXFORD.

The opposition to the proposal to add forestry as a subject of examination in the Final Honours School of Natural Science has been growing during the progress of the Statute through Congregation, and to-day Convocation voted on the form of Statute and rejected it.

The opposition which was led by Mr. C. Cookson, Fellow of Magdalen, rested chiefly on the ground that the new examination "would be inconsistent with the whole character of the Honours Schools" at Oxford, inasmuch as it would not involve "an advanced study of some one science." Mr. Cookson was supported by the Senior Proctor (Dr. Ramsden, Fellow of Pembroke), and Mr. N. Sidgwick, Fellow of Lincoln. Mr. Nagel, Fellow of Trinity, who defended the Statute, assured the House that it would not affect injuriously the character of the Oxford Honours School, and he was followed by Professors Sollas and Bourne and by the Warden of Wadham.

The votes were:—*Placet*, 98; *non-placet*, 105; majority against the Statute, 7.—(*The Times.*)

Photo.-Mechl. Dept. Thomason College, Roorkee. Photos. by S. Baxis Singh.

i. Four wild elephants in stockade, first day's drive.

ii. Tame elephants among wild ones inside stockade.

ELEPHANT KHEDDAH IN AUGUL, ORISSA.

ORIGINAL ARTICLES.

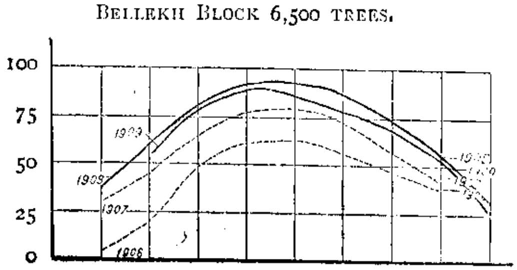
SOME FACTORS WHICH INFLUENCE THE YIELD OF RESIN FROM *PINUS LONGIFOLIA*.

From the systematic tapping of the Chir Pine (*Pinus longifolia*), which has been carried on in the Naini Tal Division for the last fifteen years, a mass of figures and statistics are available, which throw a certain amount of light on some of the factors which influence the yield of crude resin.

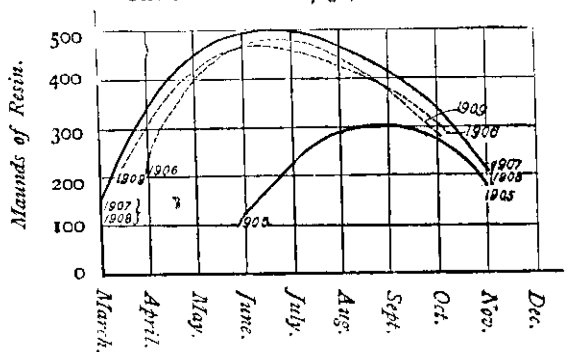
To avoid subsequent explanations, it will be useful to mention that the whole forest is lightly tapped on a fifteen years' rotation; that is to say, in any particular area, tapping is continued for five years, with a ten-year rest period (for healing up the blazes). Also, the intensity of tapping depends on the size of the tree; 1st class trees (over 6′ girth) have three blazes; 2nd class trees (4′ 6″ to 6′ girth) have two blazes; 3rd class trees (3′ 6″ to 4′ 6″ girth) have one blaze.

I.—The first and most obvious factor influencing the outflow of resin is the temperature; *ceteris paribus*, a blaze on the south side of a tree, will give more than a blaze on the north side; a southern slope will give more resin, tree for tree, than a northern slope; the hot season of the year gives a rapid outflow, the cold season practically *nil*. This is shown graphically by the accompanying curves.

BELLEKH BLOCK 6,500 TREES.



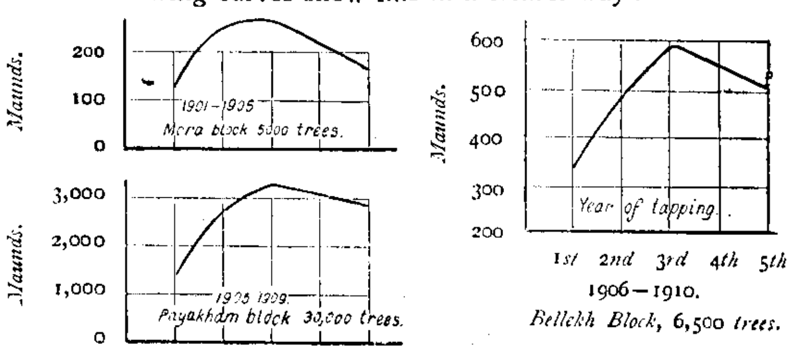
PAYAKHAM BLOCK, 30,000 TREES.



Altogether 9 curves are shown here, and in every case may be noted the rapid rise during April and May, the maximum output about July, and the subsequent gradual drop. Tapping is always stopped in November, as the outflow of resin after that month is not worth the expenditure of tapping and collection, but if the curves could be continued, they would run more or less horizontally near the zero line.

II.—Another influencing factor is also shown by the above curves. It will be seen that the curve for the second year of tapping lies entirely above that for the first year, and the third year curve above the second year; the third and fourth years' practically coincide, while the fifth year curve again drops. In other words, the year of tapping affects the yield. By tapping, the tree is artificially given a stimulus to produce resin, and in responding, gradually, works up to a maximum in the third year; and then as it becomes exhausted by the sustained effort of the waste materials required to produce the resin, the yield begins to decline.

The following curves show this in a clearer way:—



1906—1910.
Bellekh Block, 6,500 *trees*.

These curves are exceptionally regular and similar to each other, and it is unfortunate that other examples cannot be given, but in past years, during the expansion of the industry, it was customary to start tapping in new compartments at one end of a block, as fifth year compartments were dropped off at the other end, so that the total yield was obtained from compartments in all stages of being tapped. Figures from such areas are obviously useless.

III.—A third factor, which cannot easily be shown graphically, is connected with the labour employed. It was noticed that in some blocks tapping coolies were employed at the rate of one coolie to 900 trees, while in other blocks the rate was one coolie to 500 or 600 trees, and yet the cost of collection of the crude resin was less in the latter than in the former. Also, the ratio of yield (per coolie) in the two sets of blocks was annas 8 to 9. In other words block A had two coolies working 1,800 trees giving 16 maunds. Block B had three coolies working 1,800 trees giving 27 maunds. This somewhat astounding result may be explained as follows. The cuts have to be freshed periodically, thin shavings being taken off, so as to open up new surfaces of wood, as it is found that this accelerates the flow of resin. (Thus the blazes which at the beginning of the year are about 6″ long, are gradually lengthened during the year to 12—15″.)

This is done because it is found that resin exudes rapidly for a few days and then slackens off. As there are no data available, I will go by analogy, and as the maximum yield of resin is obtained in the 3rd—4th year, and in the 3rd—4th month of tapping, I will assume the maximum outflow of resin comes in the 3rd—4th day after freshening, and then proceeds to decrease. By the 7th day the outflow will have decreased appreciably, and the 8th, 9th, and 10th days will give little resin. Now, a coolie working 900 trees, has a ten-day rotation, *i.e.*, every tree is freshly cut after ten days, and a coolie working 600 trees has a seven-day rotation. Therefore, by working one coolie to 600 trees, the period of slow exudation (namely, the 8th, 9th, 10th days) is eliminated, and thus the greater yield is obtained. The yearly length of the blaze is of course, proportionately lengthened.

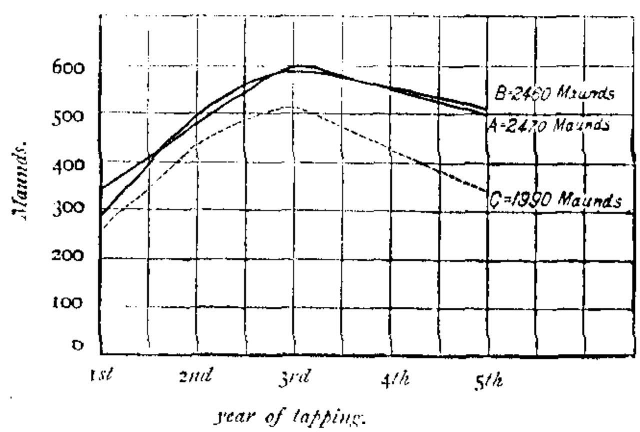
This is practically important, as it gives us a clue to the best rate of working. Proceeding to extremes, it might be asked—why not have one coolie per 100 trees? But as this would give a one-day rotation, the period of maximum outflow would never be reached, and the yield would be less.

It is difficult to show this graphically, as accurate figures showing the yield per tree per day are not obtainable. The accompanying curves, however, show to some extent the results of intensive working. Three blocks A, B and C have been taken and the yields reduced to correspond to the same standard of 10,000 blazes.

Block A was a somewhat cool area, recently and very intensively worked.

Block B was slightly warmer, and recently but not quite so intensively worked.

Block C was a hot area, but worked in the early days of the industry.



It can be easily seen that the output from the *hottest* area is the smallest.

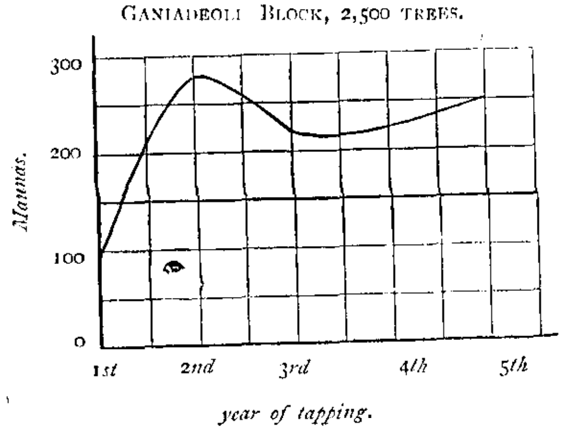
IV.—There is, however, another factor which has, in this case helped to give this result, namely, altitude. As altitude determines the distribution and, to some extent, the vigorous growth of the tree, similarly it affects the outflow of resin. Blocks A and B are

situated about the middle of the Chir zone (5,000—5,500 feet) while block C is only 4,000 feet altitude, *i.e.*, approaching the lower limit of gregarious Chir areas, where, although the heat is greater, the vitality of the crop is less, and this adversely affects the resin yield.

V.—A factor, of no practical importance, but perhaps worthy of mention, is fire. If a fire passes through an old tapping area, where the blazes have not healed over, but from which the resin has long ceased to exude, the old dry resin is burnt away, and a perfect torrent of new resin comes out from the re-opened resin ducts. This only lasts a few days, during which time the resin falls neglected to the ground, and forms rivulets of colourless fluid, meandering away from the base of the tree up to a yard in length.

In the above lines, some suggestions have been made to try and explain the facts which have gradually become evident during the practical working of the resin industry. It has been found somewhat difficult, however, to show the action of one factor only, as in the majority of cases three or four influences have been at work, sometimes counteracting, sometimes enhancing each other's effects and in one or two cases producing grotesque and irregular curves. I will conclude with an example illustrating a case where one or more factors have entirely dominated and masked another.

GANIADEOLI BLOCK, 2,500 TREES.



There is a pathetic droop about the middle of this curve and a hopeful tendency in the tail, which is not expected, and requires some explaining away. A hunt among old vouchers and cash books showed some interesting points :--

(1) In the second year the total expenditure on tapping and collection was high, in the third year extraordinarily small, and in the fourth and fifth years again higher.

(2) The cost of collection per maund, on the other hand, was relatively high in the third year. It is clear that in this year the number of coolies employed was too small, and the 8th, 9th, 10th (and possibly the 11th and 12th) days, after freshening the blazes, were in evidence. As explained above, this would account for the drop in the curve. An inspection of the area also shows a short third-year blaze, and a very long fifth-year blaze,* while the personal equation, and question of unequal supervision may also have played their part.

The curve shows at any rate that the "yearly" factor has been masked by the more potent influence of the "labour" factor.

To briefly recapitulate the chief points touched on :—

(1) The yield of resin is strongly affected by the seasons, the hot weather giving a maximum.

(2) The yield depends also on the year of tapping, the third year usually giving the best results.

(3) The suitable control of labour is important. If too many coolies, or too few coolies, are employed, a loss of resin will result. In this division, one cooly to 600 trees is found to give the cheapest and maximum yield.

(4) The more flourishing and healthy a tree is, the greater quantity of resin will it give.

As a corollary, as we approach the limits of distribution of the species, the yield decreases.

NAINI TAL:
19th March 1910.

E. A. SMYTHIES,
Assistant Conservator of Forests.

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* *I.e.*, Length : 2nd year blaze, 1′ 5″; 3rd year blaze, 11″; 5th year blaze, 1′ 6″.

REPRODUCTION BY COPPICE SHOOTS.

In the editorial article for December 1909 on this subject an excellent example was given of the "danger of adopting a European axiom blindfold." In the concluding paragraph it was stated that "bordering on our reserves in private forests where the fellings are quite unregulated, it is common to see a splendid crop of coppice shoots result, while across the boundary in reserved forests managed on so-called scientific lines we find a very poor crop indeed." I take it that there is not merely a slight difference which could only be detected by delicate and careful enumerations, but a most palpable difference evident to anyone with eyes to see. On the one side where the forests are managed by trained forest officers and where considerable expense has been incurred the results are poor. On the other side where the forests are managed in a casual haphazard manner the results are good. This offers food for reflection.

If this instance is at all typical it is evident that our methods are unscientific; that our works are not based on observations and experiments, but on the contrary are carried out with an utter disregard of obvious facts. It is, however, frequently stated or implied in articles in the *Indian Forester* that our forests are managed on scientific lines. This misconception may perhaps be partly accounted for by the fact that our training consists almost entirely of a study of German forestry. It is natural therefore that we should be greatly influenced by German notions and ideas, and as in Germany forestry has been brought to a very high degree of perfection, our enthusiasm has perhaps blinded us to the fact that what is scientific in Germany may be the height of folly in India. The tropical and natural forests of India and the conditions generally are so different to the artificial forests of Europe that there are hardly any points of similarity, and therefore when we call it scientific to measure out the same or a slightly modified form of treatment to species that differ entirely in habits and surroundings we make the same mistake as the man who fed his horse on bones and Spratts' biscuits on the grounds that his friend's bull pup was always in the pink of condition.

The care of coppice shoots is of course only one instance and it would perhaps be interesting to examine all the principal sylvicultural works carried out in each province from these two points of view: to consider in the first place to what extent they may have owed their origin to the influence of German forestry, and secondly to what extent they are founded on, or supported by observations made in India. In Burma the only sylvicultural works of any importance, on which therefore it is to be presumed we rely in order to improve the value of our forests, are fire protection and works in connection with taungya plantations. As regards the first, remembering how essential it is to preserve the soil covering and how destructive fire has been found to be in Europe, it seems inevitable that we should have attempted to keep fire out of our reserves. On the other hand no direct evidence based on actual observations or experiments carried out in Burma have been produced which in any way justify the expense of protection. As regards taungya plantations, its origin may, I think, be traced to the prevalence of even aged woods in Germany. On the other hand, it is well known that in Burma teak is naturally extremely prolific and therefore the need for expensive and laborious methods of reproduction is not apparent. Improvement fellings however are an example of the reverse. It is a work which is universally acknowledged to be indicated by the circumstances and to be justified by the facts, and the neglect of this work can, I think, only be accounted for by the fact that for this work there is no parallel in Germany.

Although I think we look at our forests through German spectacles and disregard obvious facts to the detriment of our work, I do not think this is entirely the fault of our European training. The fault is mainly, I think, due to our want of adaptability. As a nation we are extremely conservative and orthodox; we are not readily swayed by impulse or caprice or even by sound reasoning. We are apt to be self-complacent and unwilling to learn and have an instinctive dislike of sudden changes. These qualities have probably contributed to our success as a nation, but are, I think, responsible for our failure in forestry. In the Colonies for instance

the most wanton destruction of forests is tolerated, not apparently because it is not realised that it is desirable to conserve the forest resources of a country, but on account of a dislike to disturb the existing order of things and to take drastic remedial measures. That these reckless and wholesale fellings were stopped in India is due, I believe, to the clearsightedness and perseverance of a German in spite of great opposition. In England the low standard of forestry appears to be largely due to the fact that formerly it was desirable to encourage the growth of branches for the production of crooks for the navy, and no clearer illustration of my argument could be given than the fact that, although times have changed and in spite of considerable protest, the practice still prevails. In our case we are caught at an impressionable age, we are taught how forests are managed in Europe and are imbued and saturated with German ideas. The consequence is, I think, that for the rest of our lives German forestry stands for orthodox forestry and any deviation from these ideas is viewed with distrust and misgiving.

The Honorary Editor has pointed out that in the case of reproduction by coppice shoots we have suffered enormous loss by adopting a European axiom blindfold, and I think it not improbable that our disregard of facts has in various ways caused a waste of several crores of rupees. We have, I believe, passed the jubilee of the advent of the first trained forest officer into Burma, but if we look back and review what has been done, to what measure of success *in sylviculture* can we claim? We have displayed great energy and have incurred considerable expenditure, but in the case of teak which is our main source of revenue the effect of our forestry may, I think, be summarised by saying that we have been taking out the mature and over-mature trees, we have been exterminating the younger age classes and preventing natural reproduction, and have done practically nothing for the intermediate classes.

Most of us are prepared to admit in the abstract that our forests ought to be managed on scientific lines in the same way that doubtless it is realised in the Colonies that forest resources

should be conserved, but it is apparently just these simple obvioús truths that are difficult to act upon. We have acted upon the precept that it is desirable to preserve our forest resources and have taken steps to regulate the output of our forests according to their productive capacity. I need not point out what an inestimable advantage this has proved to be, but I venture to suggest that if, in order to improve the value of our forests, we acted on the principle of carrying out no sylvicultural operation unless it were based on reliable observations and experiments, the results would be no less far reaching.

RANGOON: H. C. WALKER.
February 1910.

SHIKAR, TRAVEL, AND NATURAL HISTORY NOTES.

KHEDDAH IN ANGUL GOVERNMENT FORESTS, ORISSA, BENGAL.

The dense sultry forests of Angul bordering the river Mahanadi were full of human lives in the middle of November last. Nearly 12 square miles of jungle was encircled in thick lines of smoke and fire and represented a quaint sight when looked down upon from a lofty hill peak. This Kheddah camp of Angul was a fairly big one, and the chief thing of interest in it was a large herd of tame tuskers specially picked by the Deputy Commissioner of Angul to form a guard of honour for the newly conquered kings of wild beasts.

I was deputed by the Raja of Dhenkanal to witness the Kheddah operations, and as such my duties required a careful note

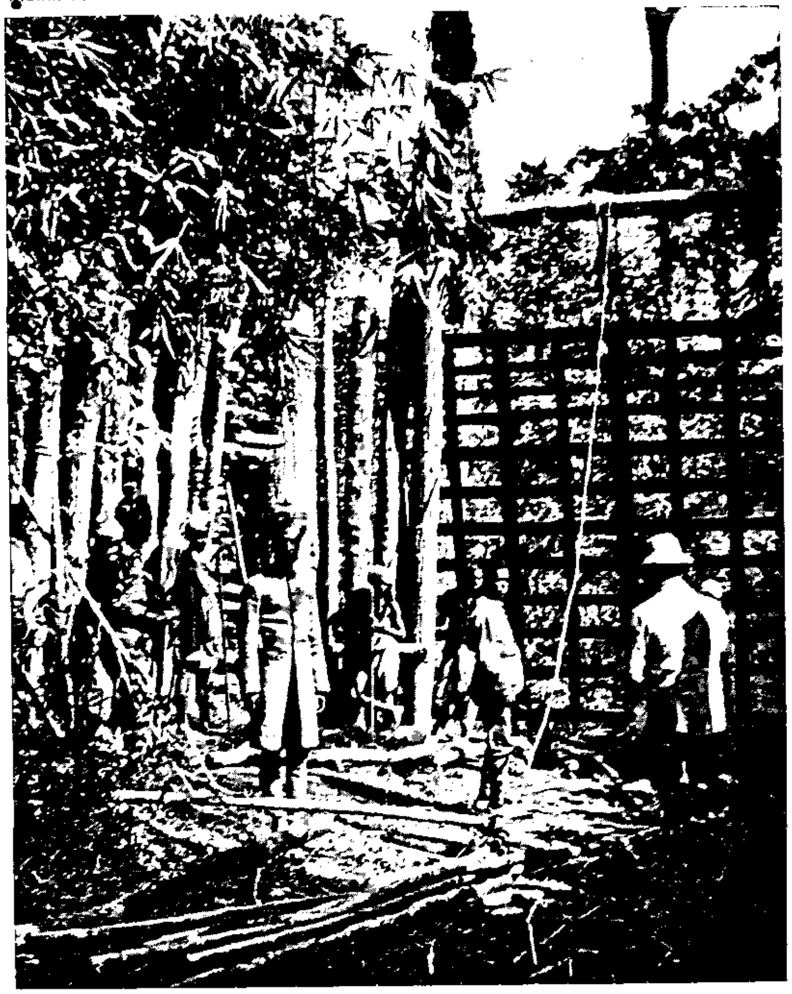


Photo.-Mechl. Dept. Thomason College, Roorkee.

Photos. by S. Baxis Singh.

i. Main entrance to stockade, door hanging down.

ii. Outer view of stockade, visitors' machan on the right.

ELEPHANT KHEDDAH IN AUGUL, ORISSA.

of all works in connection with elephant catching. Believing that my notes may be not only instructive to some extent but prove full of interest to ordinary readers, I give below a summary of them.

The preliminary arrangements for a Kheddah consist in the careful watching of the movements of wild elephants and bringing them into a specified area. For this purpose some good trackers are engaged. The aim of these trackers is not only to watch the elephants but to narrow the sphere of their free movements by slow and quiet drives. When these parties have succeeded in their aim a line of watchers is spread all round the area which in Angul was about 12 square miles. This area has to be guarded day and night. The trackers then repeat the process to bring the elephants into a still narrower space. The watchers go on shifting their lines of watch as well till the space is reduced to such a size that elephants can be driven into a stockade in a five or six hours' drive. It is worth noting that the area for the final confinement of the wild animals requires considerable forethought. It must be at least some 6 or 8 square miles, in order to afford sufficient fodder for the confined animals and should have a plentiful supply of water to keep the wild elephants contented. If this condition is violated the wild elephants, finding their confinement unbearable, would attack the line of watchers and probably rush through it. In Angul this arrangement was very nicely done and the guard round the area was very properly arranged. The final drive of wild elephants into the stockade is a very difficult task and requires considerable tact on the part of those who guide the beaters. In the Kheddah I saw in Angul the first drive was not successful, simply because one of the guides got frightened at the sight of wild elephants and fired his gun in front. The herd ran back and scattered in excitement and only four animals reached the stockade, the rest broke through the line of beaters. The second day's drive was better managed and brought in 22 elephants. The third drive brought in 19.

I think the details of the stockade are less interesting so I omit the minor details. The construction of door and outside walls

will be readily understood from the photos in plate 10. The sizes of the principal parts of the stockade are given below :—

Dimensions of stockade.—Oval in form, large diameter 125 feet, small diameter 82 feet. False stockade by which the trapped elephants are taken out one by one, oval in form, large diameter 62 feet, small diameter 40 feet—*vide* sketch in plate 12.

Stockade walls.—14 feet high, posts touching each other 2½ feet to 1½ feet girth, 4 feet buried underground, thickness of walls 4 feet. The interior of walls filled up with wooden billets. The walls supported by forked props at the outside at intervals of 7 feet—*vide* plate 10 (ii).

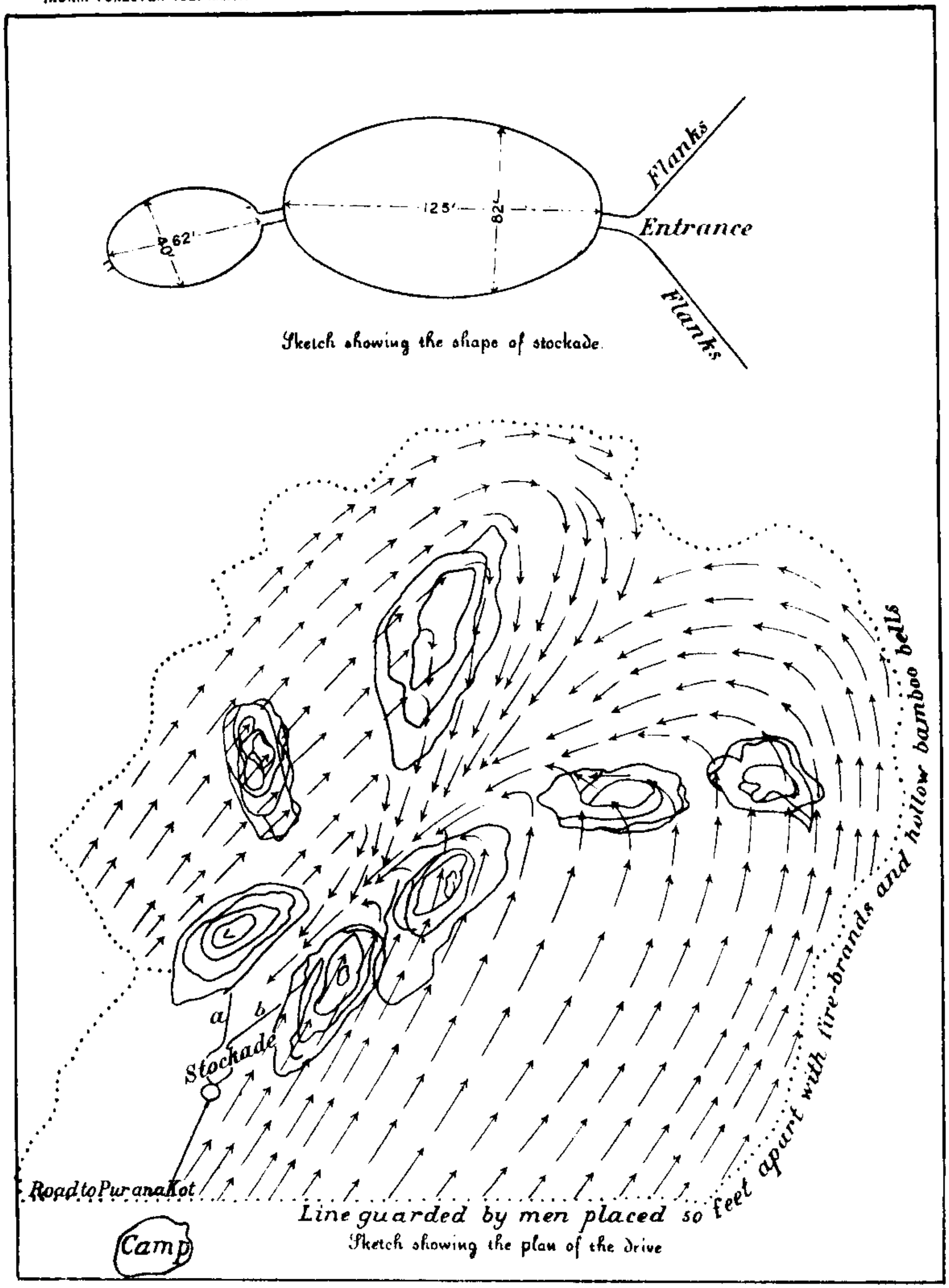
Main gate of stockade.—Height 12 feet, breadth 14 feet, actual opening 10½ feet.

The door (plate 10 (i)) is made of wooden battens 9 in vertical line and 12 in horizontal line. Size of battens varying from 5½ to 3 inches in width. The horizontal bars bear nails about 3 feet apart and 1 foot in length (6 inches in the wood and 6 inches projecting). Connecting chamber with false stockade 16 feet long 7 feet wide.

A plan of the site of Kheddah showing position of stockade and also the direction and mode of drive is given in plate 12.

It is worth noting that the watchers along the outer line must under no circumstances quit their places. The beat is conducted by a different set of men and the object of this arrangement is that in case any elephants break through the line of beaters they cannot get out of the guarded area and so may be subsequently driven into the stockade.

Plan of the site of Kheddah.—(Explanation of plate 12):—(1) The dotted line shows line guarded. (2) The direction of arrows is the direction of beat which finally leads towards the main entrance of the stockade. (3) The stockade has two side wings or flanks (see *a* and *b* in the plan). The object of these wings is to narrow the line of scattered elephants and bring them right into the mouth of the stockade. The door is raised high, the path and interior of stockade is planted with fresh cut bamboo branches to give it a natural forest appearance. Thus the elephants when frightened



ELEPHANT KHEDDAH IN ANGUL, ORISSA.

No. 6564.

by guns being discharged from behind rush into the stockade, the rope supporting the door is cut and the elephants are securely locked in.

BAXIS SINGH,
Forest Officer, Dhenkanal (Orissa).

IN A CLOSED ROOM WITH A LEOPARD.

A young pioneer farmer, writing home some little time since from Nyere (British East Africa), says: "About a week ago we had a great fight with a leopard. On the King's birthday at dusk, about 6 P.M., I walked over to see McD., my nearest neighbour, about half a mile from my place. I found another neighbour there, a Mr. S. We had dinner and afterwards sat talking round the fire till about ten o'clock. S. then left, and shortly thereafter I thought of moving too. Meantime, my little dog was prowling around outside and began barking at something. A leopard had been paying attention to S's pigs for a few nights before, and I suggested that the beast was at hand again. While we were discussing this point, in rushed the dog (the door being wide open as usual), and a monster leopard at his tail—I never saw a bigger one. It came with such a bang that it was nearly against us before it could pull up. We started shouting for fear it would collar the dog, but it was too surprised at the sight of us and at the light from the lamp, etc., to meddle with the dog. The leopard then turned towards the doorway, but missed it and got behind the door. Anxious to get out it reared itself against the wall and pawed round about to the side of the room. We had no weapons handy, but we still kept shouting at it, thinking it good fun to scare the beast, and that it would soon gain the doorway.

"As it moved about, however, it came against the door and shut it. Then the tune was changed. We saw we were in a tight place and looked round for something to defend ourselves with. There was nothing, however, and to move was only to draw the attention of the beast to us. In the meantime it was getting mad at being trapped, and kept jumping all over the place like a streak

of lightning, dishes, boxes, cupboards, pots and pans flying about, and the little dog worrying it all the time. We now had our chairs up as shields. I was nearest to the door, and began to move slowly thereto whenever the leopard's back was turned to me. It noticed what I was after, however, and was on me like a shot, with a roar or growl, paws out, and mouth wide open. I guarded with the chair, but it knocked that out of my hands, and getting one paw home on my scalp clawed it and ripped it like a piece of cloth. I kept my feet, however, though it must have knocked me violently against the wall, for my shoulder was sore for weeks after. I hammered on the beast's head with fists, but don't suppose with much effect, though it probably prevented it from using teeth and claws on my legs or body, as it kept snapping at and trying to catch my hands as I hit it, while all the time the dog was tearing at its ears. Then the dog must have gripped one of the leopard's hind legs, which made the leopard turn from me.

"Although by this time almost blinded by blood, I took the chance and lunged towards the door and threw it open. Turning I saw the brute making for Mr. D., at which I made to go round to the other side of the table to drive it from him. When about half-way I heard the door close again. I had banged it open with too much force, and it had rebounded back to its old place. I had to try again, and well for me the brute's attention was turned to Mr. D., because I had no chair then, and it would have done for me completely. I succeeded, and the next I saw was Mr. D. on the bed and the leopard gathering itself for a spring upon him. But Mr. D. was in time to lift a blanket over himself and so foil the charge. I stood holding the door open with one hand, with the other diverting the blood from my eyes. The leopard now leaped back to the floor; it seemed to be getting tired, because it stood still by the wall for a little, not far from the door. If I had got hold of a spear then I could have settled the beast. But the dog kept pestering it. Turning a little towards the dog it felt the cold air blowing in. Turning further it saw outside and trotted out. I had not even the chance of giving it a parting kick as it brushed past me, because the dog was hanging on to its hindquarters.

After getting out it must have turned on the dog, at any rate, the latter came back in a devil of a hurry.

"We had an exciting time while it lasted. After our unwelcome guest made off I lay down on bed, and my arms went as stiff as pokers. Mr. D., too, got off better than I did; he had only a few deepish scratches on his arms. When first attacked he managed to get between a ladder and the wall. While the beast was devoting its attention to me he had been feeling in the fire for a brand, but could get nothing large enough. He thereby burned his fingers badly, of which he was unaware until the danger was past, when the pain made him think the leopard must have chewed them, but on examination of his hands he remembered the cause of their damage. In the morning I was taken in a stretcher to Otjeri hospital, and have been there ever since; but I am getting along nicely, the wounds cleaning well. I have never had the courage to look in the glass at them, so do not know what they are like, but my skull is exposed in a few places, and I can hear the surgeon's instruments on the bone twice a day at dressing time. In about a fortnight he is going to let the wounds heal. Everyone has been very kind to me. They were all going to send me food, etc., but the District Commissioner and his wife said the privilege belonged to them, so I am getting all sorts of delicacies."—(*The Field.*)

EXTRACTS FROM OFFICIAL PAPERS.

SIMPLIFICATION OF THE RANGERS' COURSE AT THE I. F. COLLEGE, DEHRA DUN, AND REJECTION OF THE PROPOSAL TO ELIMINATE THE EXISTING PRELIMINARY TERM.

Government of India Circular No. 3*F.*/174-15, *dated* 18*th January* 1910, *to all Local Governments and Administrations except Madras and Bombay.*

The Government of India have now received replies from all Local Governments regarding the proposals contained in

paragraph 5 of their Circular No. 20-F./174-2, dated 22nd July 1909, to simplify the present syllabus for the Rangers' course at the Imperial Forest College, Dehra Dun, and to shorten the course by the elimination of the existing preliminary term of practical training of three and a half months, while lengthening the probationary course of training under Conservators from three and a half to six months in order that Conservators may have more time than at present to appraise the qualifications of candidates, and may be in a position to select for admission to the Dehra Dun College only those who are qualified to profit by the course of training.

2. There is a consensus of opinion that a simplification of the course is desirable and the Government of India approve of the revised syllabus recommended by the Board of Control.

3. As regards the proposal to do away with the preliminary term of practical training and to substitute for it a longer period of probation in the forests, it has been represented that it is advisable that the professors who are to lecture on forestry in the College should first obtain a knowledge of the students and their capabilities in the field and that students should receive some practical instruction from their professors on the nature of trees and woods before the commencement of their theoretical studies at the Forest College to enable them to assimilate the lectures in the class-room. It appears to the Government of India that there is considerable force in these arguments in favour of the retention of the preliminary term devoted to practical training and they have therefore decided that it should be maintained. It is open to Local Governments to prescribe any term in excess of three and a half months for the probationary course of training under Conservators.

THE AREA OF PASTURE LANDS IN INDIA AND REVISION OF INDIAN FOREST RULES.

Meeting of the Legislative Council of the Governor-General of India.

The 18th February 1910.

(THE HON'BLE MR. DADABHOY.)

VI.—Is the Government in a position to state the total area of pasture lands in the country, and, further, whether there has been a decrease in it during the past fifty years? Is it aware that the present area is insufficient for the support of cattle, and that lands that should be left as village commons are included in Reserved Forests? Will the Government be pleased to revise, with the help of a Committee on which non-officials should be adequately represented, the rules framed under the Indian Forest Act so as to have in every village a sufficient quantity of land for pasture?

(Reply by the Hon'ble Mr. Miller to Question No. VI put in Council by the Hon'ble Mr. Dadabhoy on the 18th February 1910.)

I am unable to give the Hon'ble Member definite information as to the total area of pasture lands in India as such lands are not separately classified in the Agricultural Statistics. They are included in the figures relating to fallow and waste land, and to forests which the Hon'ble Member will find in Table No. 2 at page 50 of the printed volume of Agricultural Statistics. No definite comparison is therefore possible with the conditions of 50 years ago, but there can be no doubt that owing, chiefly, to the great increase in cultivation, and in some places owing, chiefly, to the spread of irrigation, the area available for pasture has largely decreased during that period. It is impossible to say whether over the whole of India the grazing area is sufficient for the cattle; this must be matter of opinion, but there is no doubt that in many parts of the country grazing grounds have been seriously curtailed. The Government of India are not aware that lands that should be left as village commons are included in Reserved Forests, but have no doubt that any cases of the kind in which there may be room for

reasonable doubt will be carefully considered if brought to the notice of the Local Government. The subject of the maintenance or of the further provision of pasture land involves much wider considerations than the question indicates. Local Governments are fully alive to its importance. No action under the Forest Act could possibly secure the provision of a sufficient quantity of such land in every village. This could only be done by interfering with the land-owner's freedom of action in devoting to cultivation land hitherto used for pasture. As regards grazing in the forests, the rules under the Indian Forest Act are framed for each province by the Local Governments concerned, and Local Governments are *fully aware of the importance of providing grazing facilities in* forests and also of utilising forests for the provision of fodder as far as this can be done with due regard to the maintenance of the forests themselves. The Government of India, therefore, are of opinion that the Committee proposed by the Hon'ble Member could not serve any useful purpose, and they are not prepared to appoint it.

THE FORESTS OF THE EMPIRE.

The increasing interest taken in most civilised countries in questions of forest conservation is a notable proof of the growth of wisdom in the utilisation of the wòrld's resources. For centuries mankind was prone to regard forests mainly as arenas for wholesale and often wanton destruction. The forests were, as the Siberian peasants still say, "the gift of God," to be used or wasted without let or hindrance. Their effect upon rainfall and temperature, their value in preventing the denudation of soil, the large part they play in the control of rivers and the preservation of moisture were factors either not understood or disregarded. Happily most Governments are now recognising that forests are valuable assets, both by reason of the revenue they produce and the direct and indirect benefits they confer. The steady growth of checks upon the reckless exploitation of forests is a wholesome sign. Germany led the way in scientific forestry, and her splendid woodlands, now a possession of enormous value, have been to a large extent under State control for a hundred years. Austria-Hungary has long realised the importance of her forests to agriculture, particularly in the Alpine provinces, and has developed an efficient forestry system. France has not only carried out large works of afforestation on waste lands, but has exemplified the close interdependence of forests and water-supply in the official title of her Forest Department. The vast forests of Russia are slowly coming under scientific control. In the centre and south of Russia stringent measures of regulation have been introduced, though the huge timber areas in the north are still almost without State care. In Southern Siberia the process of forest extermination is now largely supervised

and in Central Asia the very special value of the mountain forests as "preservers and distributors of rain" receives constant official attention. Norway and Sweden have both begun to appreciate the fact that their valuable forests are not meant solely for destruction. The United States, already consuming three times as much timber as the country annually produces, is turning with enthusiasm to problems of practical forestry. It is curious, and not a little regrettable, that, while so much activity is visible in other lands, the forests of the British Empire have hitherto received comparatively scant scientific treatment at the hands of the State. The one shining exception is India, where an admirable Forest Department is doing excellent work. Canada is still chiefly engrossed in production, and gives little serious attention to the restocking of cleared areas, although her productivity must inevitably diminish in time. Australia has not only failed to realise the immense importance of forest conservation, but in some quarters at the Antipodes the question is even regarded as a matter of little account. In the United Kingdom the influence of forests on rainfall and water-supply is fortunately a negligible issue, but the economic advantages of schemes of afforestation are only now arousing the belated interest of the authorities.

Even in India the earlier administrators only drifted into tentative measures of forest control almost by accident. It was the possibility of using teak as an alternative for oak in the construction of warships which first led to attempts to supervise the output of the forests. That the forests of India had any direct relation with water-supply or with areas under agricultural cultivation was almost unperceived. Even to-day in India the scientific aspects of forestry are only fully recognised by very few experts. In an admirable paper* by Mr. Eardley-Wilmot, late Inspector-General of Forests in India, recently read before the Royal Society of Arts, it was pointed out that the report of the Irrigation Commission takes absolutely no notice of the relation of forests to the subject under enquiry. That is an extraordinary omission, which reveals the perils of over-specialisation. Practically one-fourth of

*An account of this paper appeared in our issue for last month.—HON. ED.

the Indian Empire is under forest, though all land labelled "forest reserve" is not necessarily covered with timber. The forests are useful for the protection of catchment areas, the maintenance of perennial streams, and the storing of moisture, and so have a very direct connexion with irrigation. Yet the Irrigation Commission sinned in good company, for it is on record that at one time the Government of India actually tried to sell outright the forests of the Central Provinces. In Mr. Eardley-Wilmot's opinions, the day may still come when the Central Provinces forests may be as valuable as those of Burma. The real father of Indian Forestry was the late Sir Dietrich Brandis, and under the policy he initiated, the Indian Forest Department has, in spite of some shortcomings, done much solid work. It came into an almost ruined inheritance, for from the time of the Aryan invasion down to the final Musulman irruption the forests of India had been neglected and laid waste. Large tracts of country in India are out of cultivation to-day owing to the ruthless destruction of trees in bygone years; but though the Forest Department has to rely almost entirely on the natural reproduction of the forests, and can therefore never hope to repair much of the evil wrought in the past, it has effectually wiped out the reproach of neglect.

So far as England is concerned, the modest grant assigned by Mr. Lloyd George for experiments in afforestation is one of the few features of the Budget which arouses little contention. The gigantic progressive outlay recommended by the Royal Commission on Afforestation cannot be contemplated without careful preliminary investigation. For the backward condition of Canada in regard to scientific forestry there is much reasonable excuse. The rainfall and water-supply of Canada are not seriously affected, and the vast areas under timber have possibly justified a somewhat reckless process of clearance, which cannot, however, continue indefinitely except under scientific direction. The successful inauguration of a large pulp and paper-making industry in Newfoundland has so far led the island State to realise the value of its forest resources that an important conference is about to meet at St. John's to consider questions of forest conservation. Nova Scotia is now taking the

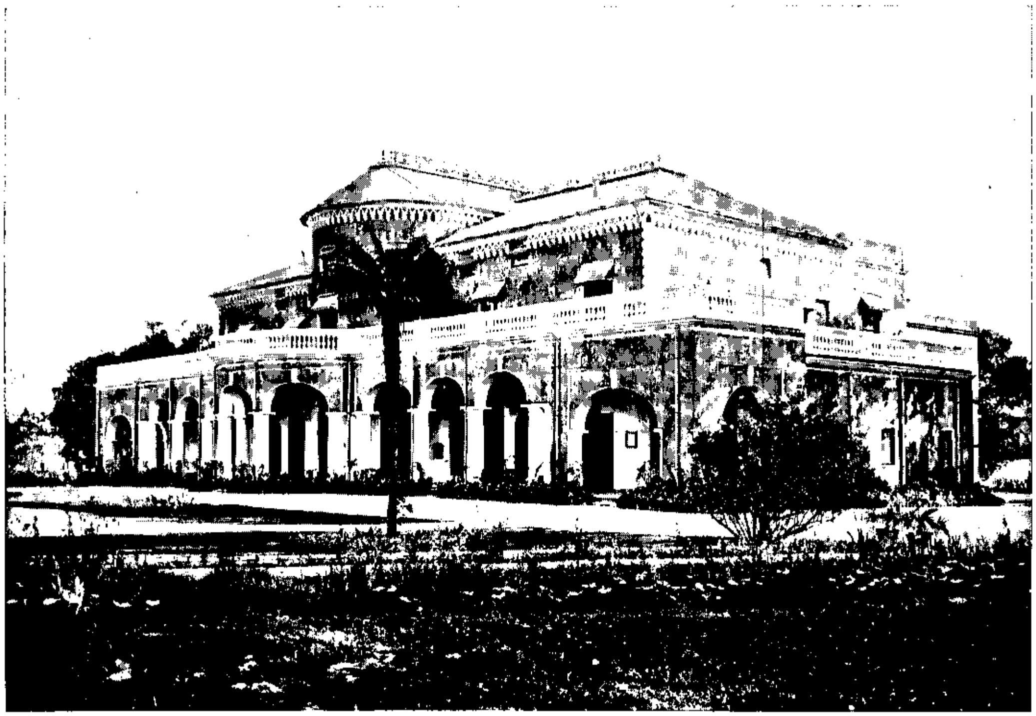
wise preliminary step of preparing an "inventory" of its forest wealth. It is melancholy to have to add that nowhere in the Empire is less practical attention paid to scientific forestry than in Australia, the country of all others where forest administration should be regarded as of the highest importance. The only plea that can be advanced in behalf of the Commonwealth and the State Governments is that they are almost overwhelmed by the many urgent questions simultaneously demanding their attention. Yet the need for a careful consideration of forest problems in Aus ralia is very pressing. The wanton sacrifice of timber in every Australian State will certainly bring retribution if it is not checked. In no country within the Empire is scientific forestry less understood; in no country is a wise forest policy more imperatively required. Mr. Newton Moore, the able Premier of Western Australia, hast just arrived in this country to make known the growing attractions of his State as a field for immigration. Mr. Moore no doubt is well aware tha the fertility of the new wheat belt which he so justly extols depends to a large extent upon the influence of climate and rainfall of the forests between the wheat belt and the sea. Forest conservation in Western Australia is, however, still in its infancy, as in all the States of the Commonwealth. The value of plantations, moreover, as a shield for the crops from hot parching winds in certain areas is still disregarded; and most of the smaller Australian townships elect to remain gaunt and unkempt when they might easily be embowered in trees. It is not, however, for æsthetic reasons, but for severely practical purposes, that a closer study of forestry is required in a continent of such uncertain rainfall. The system of "dry farming," so earnestly advocated recently in Australia by Senator McColl, is no doubt worth careful attention in comparatively arid districts; but in Australia, as in India, forestry should find a foremost place in all movements for increasing the productivity of the land.—(*Times.*)

AN AUSTRALIAN AFFORESTATION EXPERIMENT.

All over the world the question of afforestation is just now receiving the deepest attention. Here, in Great Britain, tree-planting is advocated as a means of putting to profitable use large areas of land unsuited for grazing or agriculture, and also to afford work for the unemployed. In Germany, France, Belgium, etc., it has been shown that afforestation is peculiarly an industry adapted for State activity. A remarkable instance is afforded in the Australian State of Victoria, where the Government has established afforestation on a basis of high and uniform profits. The Australians pride themselves upon their State institutions, and thus the opposition to experiments of this sort is seldom formidable. If an Australian Government wants to court popularity in the country, it undertakes an extensive experiment on behalf of the producers. In fact, the State there is asked to take an active part, not only in experimental farming of all sorts, and in tree-planting, but is constantly urged to apply its experiments on a commercial scale, and so give the landholder a clear idea as to whether a certain crop will grow in the country, and whether it will pay when grown.

The Government of Victoria decided seventeen years ago to make a tree-planting experiment on some wretchedly poor soil in the mining district of Creswick, quite useless for the grazier or the agriculturist, but typical of very considerable areas of rough lands in the continent of Australia. The particular hillside chosen is lightly covered with a lifeless clay-soil often so scanty as to lay bare the sandstone. The natural vegetation was of the most meagre and valueless kind. In the early days miners riddled the area for gold, and when the officers of the Government took charge it was a hillocky waste. The venture has been in the highest degree successful. About 700 acres of this were planted with several varieties of pine at a cost of £2 an acre, and the expenses during the period of growth have been light. To-day the pine timber on the land is being sold at prices which yield from £100 to £200 net per acre to the Government. Immediately adjoining, where no planting was done, the hillside shows through a sprinkling of stunted and valueless gum saplings.

Pine timber is imported into Australia in considerable quantities, and, in making the plantation, the most valuable of the imported species were given consideration. The Corsican (*Pinus laricio*) was used freely; *P. insignis*, the Monterey pine, was also planted, and although it is not looked upon as one of the most valuable of the pines, it is a quick grower, and is now returning the State handsome profits, its timber being used extensively for fruit packing cases. These trees were planted on a scale of 680 to the acre, and those now being felled at an age of from ten to fourteen years are yielding from 1 to 2 tons of timber, priced at from 5*s.* to 10*s.* each, or about 18*s.* a ton, delivered at the purchaser's mill. As the purchaser does all the work of felling and carting, the return to the State is considerable. The question of the State establishing its own mill is now receiving attention. The success of this experiment is likely to lead to a very large additional area being planted in Victoria. Practically all that can be said for that country is that it has a fair rainfall. Round the long ranges which form the watershed between the Australian coast and the inland, there are millions of acres of lands as suitable for timber-growing as this area at Creswick.—(*By H. S. Gullett in the Field.*)



The Imperial Forest College (Front).

The Imperial Forest College (from the East).

THE IMPERIAL FOREST COLLEGE AND RESEARCH INSTITUTE BUILDINGS AT DEHRA DUN.

SCIENTIFIC PAPERS.

THE GENUS CITRUS.

Dr. Cooke, in his Flora of Bombay, gives the following analytical key of the genus *Citrus*, which is on the lines adopted in Hooker's Flora of British India :—

(*i*) Young shoots and leaves glabrous ; transverse vesicles of pulp concrete :—

(*a*) Young shoots purple ; petals tinged with red ; flowers often unisexual ; fruit not mamillate at apex.—*C. medica.*

(*b*) Young shoots greenish white ; petals white ; flowers bisexual ; fruit not mamillate.—*C. Aurantium.*

(*ii*) Young shoots and underside of leaves pubescent ; transverse vesicles of pulp distinct.—*C. decumana.*

Hooker further gives the following varieties :—*C. medica*—Var. I *medica* proper :—Leaflet oblong, petiole short margined or

not, flowers usually numerous, fruit large oblong or ovoid, mamilla obtuse, rind usually warted, thick, tender, aromatic, pulp scanty, subacid.—*The Citron.*

Var. 2—*Limonum* :—Leaflet ovate, petiole margined or winged, fruit middle sized, ovoid, yellow, mamillate, rind thin, pulp abundant, acid.—*The Lemon.*

Var. 3—*acida* :—Leaflet elliptic-oblong, petiole many times shorter than the leaflet, linear or obovate, racemes short, flowers small, petals usually 4, fruit usually small, globose or ovoid, with a thick or thin rind, pulp pale, sharply acid. The large fruited states of this appear to assume the form of the *Citron*, and the small to approach the W. Indian Lime, which is, however, described as a bush with white flowers.—*The Sour Lime of India.*

Var. 4—*Limetta* :—Leaves and flowers as in var. *acida*, fruit globose 3—5 inches in diameter, rind thin, smooth, juice abundant, sweet, not aromatic. This includes two of Wight and Arnott's varieties (1) *C. Limetta*, Risso, (*Sweet lime*) with winged or margined petioles, small white flowers, globose or ovoid mamillate fruit, and a rind with concave vesicles ; (2) *C. Lumia*, Risso, (*Sweet lemon*) with a simply margined petiole, flowers tinged with red, ovoid-oblong fruit with a long mamilla, and rind with convex vesicles—*The Sweet Lime of India.*

C. Aurantium :—Var. 1—*Aurantium* proper :—Petiole naked or winged, pulp sweet, yellow, rarely red—*The Sweet Orange.*

Var. 2 :—*Bigaradia* :—Petiole usually winged, flowers larger and more strongly scented, rind very aromatic, pulp bitter. *The Bitter* or *Seville orange*—Wight and Arnott describe its oil vesicles as concaved in contradistinction to *C. Aurantium* in which they are convex.

Var. 3—*Bergamia* :—Flowers very small, sweet scented, fruit globose or pyriform, rind smooth pale yellow, pulp acidulous with pleasant aroma—*The Bergamotte Orange.*

Hooker further describes another species, which will be wanted for further reference, *viz.* :—

C. Hystrix—Young shoots glabrous, leaflet ovate, elliptic or lanceolate, equalling or smaller than the very broad petiole, flowers

small white, fruit globose or ovoid. Distinguished from *C. Aurantium* by the spinous branchlets, large petioles and small flowers which are 4 petalous. The fruit varies from the size of a walnut to that of a small apple, it has a very thick more or less tubercled rind and insipid or acid pulp.

The following descriptions are also required for reference, from Justus Karel Hasskarl's catalogue of cultivated plants " Horto Botanico Bogoriensi " (Batavia 1844) :—

Citrus nobilis, Lour :—Petioles almost naked or slightly winged ; leaves ovate-oblong or elliptic, and rather obtuse, serrato-crenate ; flowers with 20 stamens ; fruit depressed globose, skin very thick and easily separated, pulp golden yellow, juice very abundant and very pleasant, fruitful.

Var. 1. *Chrysocarpa*, Hsskl :—Leaves narrowed at the base and apex, rather obtuse or emarginate, petioles generally almost naked ; skin of fruit greenish yellow.

Var. 2. *Melanocarpa*, Hsskl :—Leaves with an obtuse base, often with a bifid or emarginate apex ; mature fruit dark green.

Var. 3. *Microcarpa*, Hsskl :—Leaves with an acute base, and apex either acute, obtuse or rounded ; petioles almost naked, mature fruit smaller by half, skin greenish-yellow (*Citrus japonicus.* Thub. Sbld. II. Jap. I. 35 to 15.)

Var. a—with globose friut : Var. b—with elliptic fruit.

Oranges, *Lemons*, *Limes*, *Pomeloes*, and others of the genus are so common, and, assumedly well known that ordinarily one would imagine that there should be no difficulty in saying what is what ; nevertheless one is confronted in this country with a mass of fruits which are called by one name by one person and by another name by another, and they are often so apparently different that a real trouble occurs when one tries to make out what is what in practice. This is still further complicated when an endeavour is made to fix the vernacular names to each.

From Dr. Cooke's analytical table, one would suppose it were simple enough to fix down the species, and probably even the

variety from the descriptions in Hooker; but, when it comes to practice, it is found that these do not in all cases, at least, fit in. The majority of the *pomeloes* investigated by me were *not* pubescent in respect of their shoots and underside of leaves; a large number of the *sour limes* had perfectly green, and *not* purple, shoots, and, if this were so with regard to the species and varieties about which there could be no mistake, how was it possible to trust the key for the various other forms in order to find them out. Again, although the key tells us that *C. medica* has petals tinged with red, Hooker tells us Var. 3.—*acida*, in the W. Indian form, the flowers are white, and in Var. 4.—*Limetta* (from Wight and Arnott's *Limetta*) they are also white. This upsets the whole key; as, under it, these two varieties at least ought to come under *C. Aurantium*.

In this perplexity I turned to Dr. Bonavia's "Oranges and Lemons of India." On page 81 he says: "I do not think that much reliance can be placed, for purposes of classification, on either the colour of the petals or that of the young shoots. I have seen young lime shoots more or less deeply tinged. Some times they have only a slight tinge of ochre. I have seen young shoots of the *Seville orange*, the *Khatta orange*, and the *pomelo* having the same tinge; and I have seen a *citron* with white flowers and green young shoots." Referring to pubescence on the *pomelo*, on page 34, he says:—"All the Pummelo trees I have examined can be divided into three sub-varieties as far as pubescence is concerned, *viz.*:—

(*a*) Pubescence, as is in other *Citrus*, on the young *unexpanded leaf buds only*.

(*b*) Pubescence to a greater degree than (*a*) on the young leaves and stems. This pubescence, however, is afterwards shed and neither the leaves nor green stem show any trace of it. Perhaps a magnifying glass might detect a few remaining hairs on the *edges* of the leaves and on the underpart of the midrib.

(*c*) Pubescence to a greater degree than (*b*), with the additional variation that it is *permanent*. The old green stems have it, and the oldest leaves retain it on their

edges and undersides of the midrib and petiole : also on the edges of the petiole wings."

He further quotes Loureirs and Rumphius, who also observed certain kinds of *pomelo* to be quite glabrous ; whilst on the other hand he found "the unexpanded leaves of all the *Citrus—orange lemon, citron, lime,* covered with hairs," and certain types, called by him the *kathairee nimboo* (a form of *Khatta orange*) and *Atanni* (a form of *loose jacket orange*) to be as tomentose as any of the *pomeloes*.

This upsets the whole of the authorised differentiation of the whole genus : and a first (perhaps even a second or third) reading through of Dr. Bonavia's work seems to be entirely destructive of old notions, and hardly at all constructive of new ones. It seems indeed strange that his work should have been published twenty years ago, and that nothing further, as far as reclassification is concerned, should have come of it ; for instance, Dr. Cooke's key was published many years later. If his statements are facts, and as far as I have been able, in my limited sphere, to examine them, they seem to be undoubted facts, the old misleading specific characteristics should not be repeated, but more up-to-date characters ought to be given. After perusing Dr. Bonavia's work several times, however, it is evident that he has brought to light a very large number of very important points, so that it is not only destructive of old fallacies but can be made constructive as well ; and, if it be not considered too ambitious, perhaps even impertinent, to attempt to do so in opposition to recognised authorities, I venture to put forward a constructive analysis based upon it.

It may, therefore, be of some interest to briefly refer to the types that he introduces, and show how he attaches them to the different species and varieties above referred to, and explain where he thinks different arrangements should be made. To begin with, he introduces three forms which he states are not included in any of the above species or varieties, which he calls (1) the *Katta orange*, (2) the *Jambhiri* and (3) the *Amilbéd.* He believes that the pulpless digitate form of *citron* is the *primitive citron*, that the pulp carpels have been introduced into it later, and that from the *citron* the

lemon has been derived, and he shows there are intermediate forms which he calls *citron-lemons*, or *lemon-citrons*, respectively, according to whether the *citron*, or the *lemon*, form is most in preponderance; and he believes that the *sour lemon* has been derived from the *sour citron* and the *sweet lemon* from the *sweet citron*. He considers the *sour lime* (*C. medica* var *acida*) should not be classed with *C. medica* at all, but with *C. Hystrix*; he also believes that the *Seville* or *bitter orange* has not been derived from, and is therefore not a variety of, the *Malta orange*. He believes that there are two distinct species of *sweet orange*, which are at present both clubbed under *C. Aurantium*—(1) the *Malta* or *Portugal orange*, and (2) the *Suntara* or *Indian loose jacket orange*. He believes that the *pomelo* should not form a separate species, *C. decumana*, of itself, but should be a variety of the *Malta orange*; and finally he shows that there are a considerable number of distinct sub-varieties of each of the recognised varieties.

The suggestions in connection with the *sour lime*, the *oranges*, and the *pomelo* are fairly startling to begin with, and require to be dealt with first. In respect of the *sour lime* it will be seen that even according to Hooker it forms an anomaly from the analytical key of Dr. Cooke for the species *medica*; the West Indian form, at least, has white flowers, and it is one of the two normally four, petalled *Citrus*, the other being *C. Hystrix*. Dr. Bonavia says that he has seen undoubted *limes* with purely white flowers, though usually they are slightly tinged with purple; that as (as previously explained) neither the colour of the shoots nor of the flowers is constant either in the *lime* or in the *citron* or *lemon*, those are not specific characters, and therefore there is no true reason to assume that they belong to one species: that the winged petiole of the *lime* is typical of it whilst it is not so of the *citron* and *lemon*, and as *lime* trees are practically invariably raised from seed, if it had been in its progenital state a *citron* or *lemon*, it would have had abundant opportunity for its foliage to revert sometimes to its ancestral form, which it never does. In this connection he says: "There is probably nothing in connection, with the *Citrus* that is better established than that it has

descended from a progenitor with a compound leaf. The *citrus trifoliata* plainly indicates this: allied genera the *Ægle Marmelos*, the *Feronia elephantum*, and *Limonia acidissima* and others point in the same direction." On the other hand, he says that in Etawah upwards of 300 *Malta Lemon* trees had been propagated by him, that to try and find a specimen with a margined (not to say winged) petiole he offered the gardeners four annas for each such leaf, but they could find none, and "this shows how fixed a character the *naked* petiole had become in this variety. I attribute to its absence in all these trees to their having been raised by *budding* from the original trees in Lucknow." He also says that whereas the *citron* and *lemon* are robust trees, the *lime* is usually only a bush or at most a good-sized shrub: wherefore there is reason to believe from this that they are not specifically connected. On the other hand although the typical leaves between the ordinary *lime* and *C. Hystrix* are very different, in the former the petiole being a fraction of the size of the leaf, and in the latter often as large as, or larger than, the leaf, yet an examination of small leaves of *C. Hystrix* showed that they and fully developed leaves of the *lime*, were almost identical, and the plants generally in habit (both shrubby), in spines large and small and in flowers (it will be remembered both are 4-petalled) as well: the *lime* leaves, and the skin of its fruit, were thinner in texture than those of *C. Hystrix*, but this is usually so in the case of cultivated, as compared with uncultivated, species. The *C. Hystrix* is called in Ceylon the *Lima*, *Leech Lime* or *Caffre Lime*. It seems to me therefore that Dr. Bonavia has made out a good case why the ordinary *sour lime* should not be considered as closely allied to *Citrus medica*, but should be considered as closely allied to *Citrus Hystrix*.

Turning now to the *sweet oranges*, he says (and for the reasons given I believe he is correct) that great confusion has arisen in clubbing together under that name, and, botanically under *Citrus Aurantium*, Var. *Aurantium*, two totally distinct species, which he calls (1) the *Malta* or *Portugal orange*, and (2) the *Suntara orange* (more commonly known as the *Indian*

Loose Jacket). He describes these as follows, shown in parallel columns for reference :—

Malta orange.— Tree not slender : leaves, typically large with a *faint* and indistinct scent; petiole, oftener only margined than winged ; spines, usually mere points ; flowers, large white ; *fruit*, with a *closely fitting skin*, never baggy ; when cut open, a distinctive odour is emitted, which I found common to all varieties of this type, and which cannot be described in words ; pulp, not of a bright orange, often only yellow-orange ; centre small and mostly not hollow ; seeds, *white* when cut. In some varieties the pulp is streaked with blood or claret-red ; in others, the whole pulp is of this colour. The latter varieties have usually a redder exterior than the bloodless ones.

Suntara orange.— A small, slender tree with slender lanceolate leaves, sometimes as small as those of common *myrtle*, and with a distinct *strong* scent ; flowers, small, the main crop of which come out in February or March, and the after or *Dumrez* crop in June or July, during the rains ; fruit, varies in shape from flat, oblate-globose to pyriform, sometimes quite smooth, at others sub-warty. The colour varies from orange-yellow to lobster-red and sometimes in part to tomato-red ; it is mostly baggy, with loose skin, sometimes so loose that the pulp-ball wobbles inside it ; the white pithy part between the rind and the pulp is frequently almost absent, and the large oil cells of the rind can be easily dissected into balloon-shaped vesicles : the colour of the pulp is often much deeper than the bloodless kind of the Portugal type. The flavour varies from very sweet to a mixture of sweetness and sub-acidity (which most of them have), and to a pure acid. The centre of the pulp-ball is mostly hollow, and the carpels loosely adherent. The seeds are *green* when cut.

The *Malta orange* was called *Aurantium Sinense* by Gallesio and the *Suntara orange* the same name by Rumphius; the former was referred to by Rumphius, Dr. Bonavia considers, as *Aurantium verrucosum*. Possibly the adoption of the same name for the two different types by two different authors led to confusion, but undoubtedly confusion seems to have occurred. With regard to the *Suntara orange*, Dr. Bonavia says: "The *Keonla** and *Mandaim* varieties of oranges, with others, are much allied to the *Suntara* race. They are totally different from the Portugal type"; and again, "I have seen none of this (*Suntara*) type in the English shops. It is loose-skinned, and the nearest approach is the *Mandaim orange* (called *Tangerine* in the English shops)"......"The *Mandaim orange* proper, I think, belongs to this group, but is a totally distinct orange. I believe it to be the same that Rieso called *Begaradier a feuille de myrte*. Its exterior is so shiny that it looks as if it had been varnished. Plate 116 (A) is taken from Flor. Amboin of Rumphius. He calls it *Aurantium Sinense*. His description of it coincides with that of the *Suntara orange* of India. Loureiro refers to this plate under the name of *Citrus nobilis*, and de Candolle, under the name of *Mandarin*, gives Loureiro's botanical designation. Loureiro, however says that his *C. nobilis* agrees most with the *Au. sinense* of Rumphius, but even this, he says, *does not coincide* with his description of *C. nobilis*." Every one knows that the *Indian Loose Jacket* is very much like the *Tangerine* of English shops, but that it is different: the *Tangerine* has a characterstic odour and flavour that is quite different to the *Indian Loose Jacket*; and the latter is larger, but it is almost evident that one is very closely allied to the other. Dr. Bonavia says elsewhere: "In Ceylon I found the *true Mandarin* in the Peradeniya Botanic Gardens. Both the scent of its leaf and that of its rind were unmistakably those of a *true Mandarin*. I did not, however, see it anywhere out of Peradeniya, and the oranges in Colombo and Kandy market, which *go by the name of*

* Another form of "*loose jacket orange*" with green seeds with a characteristic aroma distinct from either that of the *Suntara* or of the *Mandaim*, and with fruit that is not sweet till almost over ripe.

Mandarins, are only varieties of the *Suntara* and *Keonla oranges* and not *true Mandarins*." He also says that in Ceylon, Nagpore, and elsewhere, there is a variety that is "always eaten in its green state," called the *Green orange* (*Kondanaran* in Ceylon). He further shows that there is another variety permanently sour usually with much smaller fruit called the *Hazara orange*, which he says is simply an overgrown *Kumquat*, whilst what is known as the *Surk nimboo orange* is merely an overgrown *Hazara*. Now if we turn back to Hasskarl's description of *Citrus nobilis*, given towards the beginning of this article, which is extracted from Dr. Bonavia's appendix 67, we see that there are three varieties: (1) *Chrysocarpa*, (2) *Melanocarpa*, and (3) *Microcarpa*, and *Citrus nobilis* itself is known to be the *true Mandarin*; the variety *Microcarpa*, otherwise known as *C. japonica* is the *Kumquat*; against the second variety, *Melanocarpa*, there is a note by Dr. Bonavia himself: "Probably the *Green orange of Ceylon*." and yet it does not seem to have occurred to him that the second variety, *Chrysocarpa*, is his *Suntara orange*, although it agrees with it in every respect. It seems, therefore, clear that the *Indian Loose Jacket* is not *Citrus Aurantium*, but *Citrus nobilis*, variety *Chrysocarpa* of Hasskarl. It is further probable that the *Kumquat* is the primitive form which both the *Mandarin* and the *Indian Loose Jacket* (together with its green variety) is descended.

Turning now to the *pomelo*, Dr. Bonavia has shown that mere pubescence is *not* a specific character: and he has further shown that pubescence is *not* at all a constant character for the pomelo, wherefore he argues that it is incorrect to separate it off specifically for that character alone from all other types of *Citrus*. He does not argue the question of concreteness and distinctness of pulp-cells, but it can be seen from his diagrams, as clearly as possible, that it is purely one of degree: in no *Citrus* are the pulp vesicles truly otherwise than distinct. He says that he has found male and hermaphrodite flowers on almost all kinds of *Citrus* (footnote page 60), so that unisexuality and bisexuality cannot be deemed a specific character: and he says that the mamilla is quite an indefinite character, and is not constant in any species or even in any variety.

In these circumstances, therefore, it would seem that not a single one of the recognised characters separating the various *Citrus* into genera holds good.

If then the *pomelo* is not separated, by its pubescence and distinct pulp vesicles, from all other species of *Citrus*, what is it? Dr. Bonavia thinks it is an "elephant" form of the *Malta orange*. His remarks on the "elephantism" of the various forms of *Citrus* are exceedingly interesting, and well worth quoting more or less *in extenso*, in spite of the fact that I think that he has perhaps made a mistake in the point as to which was parent of the other, for reasons which I shall explain later. He says: "Leaving pubescence out of consideration now that we know it does count, we have a closely fitting skin like that of the *Malta orange*. The emarginations at the base of the pulp carpels, as shown in section, appear to be the repetition of similar ones often met in that orange. They are the commonest in the *pummelo* and *Portugal orange*. Then the *pummelo* and the *Malta orange* are the only *Citrus* I have seen which present varieties with red or blood colour in their pulp, while the *Amilbeds* have often an orange tinge in their pulp.

"The lemon coloured exterior of the *pummelo* might perhaps seem a difficulty, the Malta type of *Citrus* being orange. Besides different shades of orange in different varieties, I have shown that in Kandy they have an orange of the Malta type, with purely citron yellow exterior like that of *pummeloes*. Moreover, I have seen *true pummeloes* with *red cheeks*.

"Risso, p. 132, says of the *pummeloes*—" En effet, les pompel mousses ont de l'affinite avec les oranges douces, et avec les lumies, qui sort deux groupes trés èloignés l'un de l'autre." While Gallesio groups the *Pomo d' Adamo*' of Palestine (a *Shaddock*) with the *Seville orange* and says it is intensely bitter.

Further the *Jhambiri** presents two varieties, one yellow, skin red, the other orange—skin red. Otherwise they appear indistinguishable. The yellow skin of the *pummelo* would naturally carry with it a pale pulp, which afterwards may by reversion have

* An acid *Citrus* of deep yellow colour with fruit and foliage that of the *Suntara* orange.

acquired some blood colour, increased later by selection. So that we have now white, pink, or beef-coloured *pummeloes*: others with mixed colours and entirely yellow, and also red-cheeked *pummeloes*. As to the tomentum of some varieties, it may originally have been part of the general elephantisation of the whole tree; that is a luxuriant growth of the natural tomentum found on the young unexpanded leaf-buds of *most Citrus*. In the *pummelo* proper we also find typically huge leaves of a leathery consistence, and enormous petiole wings which are also indicative of luxuriance. This increased tomentum in some varieties may have been subsequently lost by reversion to its original scantiness.

"If the foregoing arguments are well founded, we ought to find 'elephant' varieties in other types of *Citrus*; and so we do, in abundance. The *Kathairee nimboo*, curiously enough, a very tomentose variety—appears to be an elephant form of the warty *Khatta* orange.* The *átanni* also tomentose, appears to be the elephant variety of the *Suntara* group. The *Kumaon lemon* or *gulgul* may be taken as the elephant variety of the *lemon* group; and the *Mawling* of Mangalore, and the *Madh kakree* of Almora, would perhaps be the elephant representatives of the *citron* group. For all I know there may be others which I have not come across. It would, therefore, appear that each type or race of citron has, or may have, its variety *decumana*. If so, it is no wonder that the *wild original* of the *pummelo* has never yet been discovered. It probably only required the evolution of a yellow orange, like that of Kandy, for this *decumana Citrus* to have come into being first as a product of luxuriant growth, and afterwards as the result of selection. The only parts of this *Citrus* which have not been elephantised are the spines. These, however, are usually well developed under conditions just the *opposite* of luxuriance, some of the branch buds, instead of developing normally remaining dwarfed as spines. If grown from seed, however, the spines of the *pummelo* might also be large, like that of most other seedlings.

* * * * *

* A *Citrus* with large 5-petalled flowers tinged externally like those of lemon; otherwise as in other oranges and with a dimorphic fruit, smooth in the hot-weather crop, very warty in the after-rain's crop.

"Considering the numerous varieties of *pummelo* there are in India at the present day—the white, the pink, the red pulped ; the oblate, the globose, the pyriform, the very large, the middling, and the small ; the sweet, the sour, and the acid ; the thick-skinned and the thin-skinned ; those with rounded, emarginate leaves and those with long lanceolate leaves ; those with lemon-coloured fruit, and those with a blush of red ; finally, the tomentose, the semi-tomentose, and the glabrous varieties—one might, perhaps, infer from this richness of varieties that there must be in India some centre of wild *pummelo*, from which all these have originated. Yet nothing appears clearer than that the *pummelo* proper is of recent introduction in India, by way of Batavia and Calcutta, and perhaps also southern India.

"From all that can be gathered, it appears likely that the *pummelo* was evolved, or at all events got its modern characters fixed, in the Malayan Archipelago. It should not, however, be supposed that India was incapable of evolving a *pummelo* of its own. Three hundred years ago the Emperor Baber attempted to describe the *Amilbed*. This appears to have originated in a yellow-skinned variety of some sour orange, not improbably a close ally of the *Aurantium sinense* of Gallesio. It has a closely fitting skin, an orange or white pulp, and a leaf with the characters of the *Malta orange* leaf. Three hundred years ago it appears to have been uncommon in India, and even now it is cultivated more as a curiosity than for commercial purposes. Being sour, and there being many other sour *Citrus* of a more convenient size, it has never become widely disseminated."

It is advisable here to make an interpolation about the "*Batavian oranges of the Northern Circars*" ; and here it must be remarked that its name *Batavian orange* is significant, seeing that, Dr. Bonavia lays stress on the names of the *pomelo, viz., Batabi lemboo, Mahtab* (corruptions of Batavia) and *Chakotra* (corruption of Jacotra, the old name of Batavia). Dr. Bonavia says that the only difficulty in proving the transition from the *Malta orange* to the *pomelo* is the want of a *Malta orange* with a yellow, instead of an orange, skin ; he says, however, that one actually does so exist in

Kandy. But in the *Batavian orange of the Northern Circars* " there is even a further transition; undoubtedly an orange, as it has though to a far less developed degree the exact flavouring of the *Malta orange*; it is picked green (a green that is the exact colouring of the ordinary green *pomelo*) and is eaten, ripe, either green or just beginning to turn citrine yellow, or wholly citrine yellow; the pulp is quite pale, and almost white. This is also in common parlance called a *Sweet Lime*, but as the *Sweet Lime* has a *non-aromatic* juice, this is *not* a *sweet lime* as the flavouring is distinctly that of a *Malta orange*, but not so pronounced; and it most certainly is not Wight and Arnott's *C. Limetta* as shown in the Icones. Dr. Bonavia does not deal with Risso's *C. Limetta*, the "*Sweet lime*," he merely says that *C. Lumia* is often wrongly called the *Sweet lime* instead of the *Sweet lemon*. He says that the *Sweet lemon* agrees in every way with the *Sour lemon* except that the flowers of the former are pure white instead of tinged purple, and that its juice is sweet without a vestige of acidity instead of sour. "Judging from the fruit and leaves one would say it is an acidless variety of the *Kalan kaghsi* or *Lemon*. Judging from the flowers, a lemon coloured orange of the Malta type;" but it must be mentioned that he has also found white-flowered *citrons* and white-flowered *lemons*. But whilst he shows that the *Sweet lemon (Lumia)* is a *robust tree* with normally 5-petalled flowers, White's Icones show the *true Sweet lime* (*Limetta*) is a *bush* with normally 4-petalled flowers. This, according to Dr. Bonavia's arrangement for the *lime* (*acida*) and *lemon* (*limonum*) would put them in distinct classes, and considerably remote from each other instead of as classified in Hooker's Flora, the same variety of one species.

There are three types that are not ordinarily recognised which Dr. Bonavia considers just as distinct as the *Lemon citron*, etc. The first of these he calls the *Khatta orange* or *Kharna orange* which has large 5-petalled flowers tinged externally like those of a *lemon*, but with the foliage and other parts resembling the *orange*. It is evidently an intermediate, and is a further proof that there is no specific difference between the *citron* and *Malta orange* types:

but the chief characteristic is that there are two crops of fruit, one in the hot weather which produces a normal fruit like that of an *orange*, and the other "Dumrez" crop after the rains which has the fruit so exaggeratedly warty that it has no resemblance to the ordinary *orange*. The second species he calls the *Jhambiri*: this belongs to the *Loose Jacket* class, the leaves resembling mainly the *Keonla* group but in some cases enormous; the flowers and young shoots are, however, tinged purple; the fruit is permanently acid, mostly mamillate, varies from smooth to chagrined and sub-warty, the colour of the rind either lemon-yellow or orange, and of the pulp white, or pale with an orange tint, or orange. The third is the *Amilbed*, already referred to which is a permanently sour *pomelo*, with a leaf having the characters of the *Malta orange*, a fruit with closely fitting skin, and an orange or white pulp. Besides these three, there is class that he calls *Pommelo lemons* including the *Sadaphal* and *Attara*. These are evidently an intermediate between the *pomelo*, or rather perhaps the *Amilbed*, and the *lemon*. He also gives a variety of the *lemon* that seems to be half way between an *orange* and *lemon*, which is called *Pahari nimboo*.

I do not propose referring to all the numerous forms shown to exist by Dr. Bonavia, but will endeavour to put them in their proper places in a synoptical table at the end; but it was necessary to deal with those alluded to, in order to see the groups into which the genus divides itself. It may then be said that there are four defined classes. First there is *Citrus trifoliata* with trifoliate leaves often cultivated and therefore (as all others are more rather than less cultivated species) necessary to notice; but evidently the most primitive of all the types: the others all have simple leaves. Next there are small trees, shrubs or bushes with normally 4-petalled flowers, white or tinged with purple, leaves small with a winged petiole fruit with an adhering rind, pulp greenish or light yellow, seeds white, represented by the *Caffre lime*, *Sour lime* and the *Sweet lime*. Thirdly, there are slender trees or large shrubs with branchlets usually green (but not always) and with normally 5-petalled flowers, usually white (but not always), generally small, leaves small with distinct aroma and usually with no wing to the

petiole, fruit baggy with the skin very loosely attached to the pulp ball, carpels loosely adherent, seeds green when cut; these include the *Mandarin, Suntara, Keonla*, and *Ceylon green oranges, Jambhiri*, and sundry allied types. Fourthly, there is a class of robust trees with branchlets purplish or green, with fairly large leaves, aromatic or not, with winged petiole or not, flowers normally 5-petalled, usually purple-tinted (but not always), fruit always with a tightly adhering rind, and more or less tightly adhering carpels, and with seeds white when cut; these include the *Pomelo*, *Malta orange*, *Seville orange*, *Sweet lemon*, *Lemon* and *Citron* and sundry other allied forms.

I must now refer to his suggestion that the *lemon* is derived from the *citron* making the *digitate citron* the *Primitive citron*; and also that of the *pomelo* being derived from the *Malta orange*. In both cases I venture to suggest that they should be the other way about. Taking the latter first, it must be mentioned that he has taken the trouble to show that the primitive form of the genus is a type with a compound leaf, and considers that the *Leech lime of Ceylon* (*Hystrix*) with an enormous winged petiole is the nearest approach of the unifoliolates to the trifoliolates, and that the *sour lime* (*acida*) is closely allied to this because of the typically winged (though much smaller) petiole. Following this line of thought, the *pomelo* with its large winged petiole is nearer the primitive form of the genus than the *Malta orange* where it is "more often margined than winged," and still more so than the *Malta lemon* where the naked petiole has become "a fixed character in this variety" owing to cultivation by budding instead of reproduction by seed. The size of the spines point in the same direction, although not quite so prominently: in the *pomelo* they are large, in the *Malta orange* they are reduced to mere points. But it seems to me that the *pomelo* is a fruit that possesses four different characteristics in respect of flavour; sweetness, aroma, bitterness, and acidity; that the *citrus* genus is one that has been cultivated for ages, and cultivated in different modes so as to produce fruits that develop one or more of those flavours distinctly from the remainder; the *lemon* is cultivated for acidity

and aroma pure and simple; the *Seville orange* is cultivated for bitterness, aroma, and a modicum of sweetness in its rind and acidity in its pulp; the *citron* is cultivated for aroma and a fair amount of sweetness and a modicum of bitterness in its rind, whilst its pulp is not required; the *orange* is cultivated essentially for juice, sweetness and aroma, with a small modicum of acidity and even of bitterness to prevent mawkishness in its pulp, and its rind is not much cared for, except in so far as its aroma tends to make it palatable. It would seem then that all the different types are derivable from the *pomelo*, and from no other type; and although the *pomelo* is cultivated as a fruit in itself (whence there are so many varieties) yet it could, and probably does, form the basis, of all the rest; and from the forms that Dr. Bonavia has shown to exist, there seem to be varieties which may be reckoned as the intermediates between it and each of the final types, referred to above. Although it may be unlikely that the *Seville orange* comes direct from the *Malta orange*, it seems highly probable that it should come from the *pomelo* by a judicious cultivation of the bitter principle of the rind and the acid principle of the pulp. It seems quite likely that by developing the acid principle in the *pomelo*, the *Amilbed* was formed, and as this was not, as Dr. Bonavia explains, a convenient size, being much too large, it passed through various forms, which are noted (though not intentionally to show this) in his work, down to the *lemon*, which may be considered the perfection of that type. Similarly with the *citron*, which probably passed through not only the sour forms of the *lemon*, but also the sweet forms of the *sweet lemon*, and possibly through the *Seville orange*; and I take it that instead of being a primitive form by nature, the pulpless *digitate citron* is the perfection of a *citron* brought about by human action, just as all gardeners try to reduce the seed in edible fruits to a minimum. The *Malta orange* too is the perfection of its type, and its transition from the *pomelo* seems fairly clear.

So the whole genus is essentially a *cultivated genus*. If there are any indigenous forms in India, they are insignificant compared with the cultivated forms; and it is just the differences between

these cultivated forms that we want to be able to discriminate. Being cultivated, it is obvious, that not only may there be innumerable transition forms but also retrogressive forms wherever the cultivation has ceased to be intense. This being so it is well nigh impossible to say where a species really begins and ends. It is possible that truly there are only four species, *viz.*, (1) the trifoliolate shrubs, (2) the unifoliolate normally 4-petalled shrubs, (3) the unifoliolate normally 5-petalled loose-jacket-fruited, green-seeded, slender trees, and (4) the unifoliolate normally 5-petalled tight-jacket-fruited, white-seeded robust trees; but, as this would involve a very large number of varieties and sub-varieties, and even again sub-varieties of the sub-varieties, it is better to consider the above four divisions as sub-genera. The following synoptical table is only intended to be tentative, and the botanical names adopted have been so simple so as to discriminate between the different forms because, as Dr. Bonavia shows, the vernacular names are often used to represent totally different forms; wherefore it is essential to fix a name to each individual form.

Synopsis.

I.—Leaves 3 foliolate, leaflets sessile, more or less obovate, often emarginate serrate petiole winged :—

(i) Shrub about 4′, branches robust, often more or less flattened; bearing stiff spines: fruit spherical, orange-yellow, about 1½″ diam. :—*C. trifoliata.*

II.—Leaves 1 foliolate :—

A.—Small trees, shrubs or bushes, spinous; flowers, normally four-petalled, small, usually white; leaves aromatic, small; petioles almost always winged; fruit, small, rind tightly adhering, carpels 8—14, pulp sour or sweet, but not aromatic, greenish or greenish-yellow, seeds white when cut :—

(i) Fruit permanently sour :—

(*a*) Petiole usually as large as, or larger than, leaf-blade; leaflets ovate acute crenate, aromatic *sui generis;* flowers, usually white; fruit, the size of a walnut

to that of an apple; rind thick warty bitter acrid, unpleasantly and resinously aromatic, pulp greenish :—*C. Hystrix.*

[*The Lima, Leech Lime or Caffre Lime of Ceylon.*]

* Leaves and petioles entire, fruit smooth :—var. *a aurarius.*

[*Goldsmith's Lime of N. India, Lemon mass.*]

(*b*) Petiole much smaller than leaf-blade, leaflets ovate, obovate or suborbicular, subacute or obtuse at apex, base rounded or narrowed crenate, aromatic *sui generis,* petiole wing often crenate; flowers usually purplish; fruit., globose, ellipsoid or ovoid, 1"—4" long 1½"—2" diameter, mamillate or not, usually smooth, rind citrine usually thin, pleasantly aromatic; pulp pale, greenish-yellow; carpels 8—11, centre solid:—*C. acida.*

[*The Sour Lime of India, Kaghzinimboo.*]

* Spines medium; petioles narrowly winged, margined or sometimes naked; fruit pyriform, 2¼"—3" diameter, usually, mamillate furrowed, but neither rough nor very smooth, rind not thin, pulp, sour with generic aroma.

[*Beharinimboo of Lucknow and Shahjahanpur.*] Var. *a pyriformis.*

(ii) Fruit at least ultimately sweetish, watery, sometimes bitter but not aromatic :—

Low, very ramous, erect thorny bush; leaves ovate, apex acute, base obtuse serrated, petiole winged or margined, fruit globose or ovoid, shortly mamillate at apex 3"—5", rind thin, smooth citrine, carpels about 10:—*C. Limetta.*

[*Sweet Lime, Bergamot Lemon.*]

[NOTE:—Wight's Icones show this to be a four-petalled bushy form, and it seems evidently therefore that it should come in this class, probably the most advanced of the three species.]

B.—Small trees or shrubs, slender, not or sparingly spinous; flowers normally five-petalled, small, usually (but not always) white; leaves, small, characteristically aromatic

for each species; petiole naked or margined, not winged; fruit usually small, often baggy without, or with scanty pith between the characteristically aromatic rind and the pulp-ball to which it loosely adheres, centre of pulp-ball usually hollow; carpels loosely cohering, seeds green when cut :—

(i) Fruit permanently sour :—

(*a*) Shrub, 4′—6′; leaves, small, ovate or obovate, acute, rounded or obtuse at apex, acute at base, with a feeble scent, serrated near apex, petiole naked or margined only; fruit, globose or ellipsoid, about ¾ diameter rind greenish-yellow, carpels 5—7 :—*C. japonica.*

[*Chinese and Japanese Kumquat.*]

* Fruit, yellow-orange to orange-red, oblate, smooth or chagrined, ¾″—1½″ diameter; pulp orange, carpels 6—7 :—

Var. α *Hazara.*

[*Indian Kumquat, Hazara orange, Bigaradier chinois.*]

** Fruit, reddish-orange, very smooth polished, globose, 2″ diameter, pulp, orange-yellow :—

Var β *lakkanovensis.*

[*Larger Indian Kumquat, Surkhnimboo orange of Lucknow.*]

(*b*) Small tree or shrub, leaves ovate or elliptic, narrowed to both ends; apex usually notched, somewhat lemon-scented, serrate-crenate, petiole naked or margined only; fruit, sub-globose or ovoid, 2″—3″ diameter, with a mamilla (usually depressed) at apex, with folds at base, rind thick, lemon-yellow coloured, somewhat lemon flavoured but unpleasant; pulp, pale or lemon-yellow, very sour, centre hollow, carpels 9—12 (usually 10) :—*C. Jambhiri.*

[*Jambhiri orange, Lime loose jacket.*]

* Fruit, orange-coloured, pulp tinged with orange or orange-coloured, otherwise as in type.

Var. α *chrysocarpa.*

[*Orange coloured Jambhiri.*]

(ii) Fruit, at least ultimately, sweet or subacidly sweet :—

(*a*) Slender tree ; leaves, ovate or elliptic, sometimes broadly usually obtuse and emarginate at apex, acute at base, distinctly crenated, with characteristic *sui generis* aroma (but approaching that of *C. Jambhiri*), petiole naked or only margined ; fruit, oblate or subpyriform 2¼"—3½" diameter ; often with a flattened or depressed mamilla at apex, and folds at base, usually warty on the surface or chagrined, rind usually lobster-red strongly aromatic and loosely attached ; pulp orange, sour until very late ; carpels 9—12, centre hollow :—

C. crenatifolia.

[*Lemon-scented loose jacket, Keonla orange, Kan orange of China.*]

* Fruit flattened and in folds like a tomato, deep orange to lobster red with apex often still brighter red, 2" diameter, rind loosely attached, pulp deep orange does not sweeten completely but remains subacid :—

Var. *α lycopersicæformis.*

[*Tomato orange, Reshmi orange, Heennarun of Ceylon.*]

* * Leaves narrower and more acute towards apex, but possessing the aroma to a greater extent, than the type : fruit, oblate, globose 1½"—1¾" diameter, chagrined especially towards apex, rind deep orange-red, strongly aromatic, very oily, loosely adherent, pulp orange, sweetening when ripe :—

Var. *β kokni.*

[*Kokni orange, China orange of Saharanpur.*]

(*b*) Slender trees : leaves ovate-lanceolate or lanceolate acute at apex with sometimes notched tip, acute narrowed or rounded at base, with characteristic *sui generis* aroma, serrate, petiole naked or margined ; fruit flat oblate-globose or pyriform, smooth or chagrined and warty, 2"—3¼" diameter, rind orange-yellow to lobster-red (usually bright orange) aromatic, thin, baggy, loosely attached pulp deep orange quite or

subacidly sweet when ripe, carpels 7—14, usually 10—11, centre usually hollow :—

C. chrysocarpa.

[*Sylhet orange, Coorg orange, Common Indian loose jacket, Suntara orange, Kamala orange of Bengal and South India.*]

* Leaves often broader at the base, fruit dark-green when ripe :—

Var. α *melanocarpa.*

[*Green orange, Kondanarun of Ceylon.*]

* * Stems, when young, and leaves, pubescent latter leathery, fruit usually pyriform 3¾″—7¼″ diameter, rind aromatic and pungent yellow or maize-orange coloured, reticulated into squares or triangles by slight sinuous furrows, connected by a thick spongy white pith but easily separated from the pulp-ball, pulp a pale orange or pinkish orange, subacidly sweet when ripe, carpels 9—12, centre hollow :—

Var. β *decumana.*

[*Pomelo loose jacket, Atanni orange.*]

(*c*) Slender trees up to 15 feet; leaves small often myrtle-like, ovate-lanceolate, ovate-oblong or elliptic, acute at both ends, densely inserted and sub-imbricate on the branches, with strong characteristic *sui generis* aroma, crenate serrate, petioles naked or margined ; fruit usually oblate, sometimes globose or pyriform, rind orange-yellow to lobster-red, smooth or chagrined, very shiny, usually folded at base, with strong characteristic *sui generis* aroma and flavour, thin baggy loosely attached, pulp deep orange, quite sweet when ripe, carpels 10—12 centre hollow :—

C. nobilis.

[*Tangerine orange of English shops, True Mandarin orange, Bigaradier à feuille de myrte.*]

C.—Robust trees up to 30-40 feet, copiously spinous in the less highly often cultivated forms : flowers usually normally five-petalled, tinted with purple ; leaves large, aromatic or but

slightly so, petiole largely winged in less highly cultivated forms decreasing to a margined or naked petiole in more highly cultivated forms ; fruit usually large to very large, skin closely adhering by means of a white pith to the pulp ball, centre of pulp ball often filled with pith, carpels more or less tightly cohering, seeds white when cut :—

(i)—Fruit permanently sour ; leaf petiole normally winged :—

(*a*) Spines small, leaves mostly obovate crenate glabrous or pubescent, petiole usually with small wings, fruit 3″—5″ diameter, occasionally with mamilla at apex and folds at base, rind pale or lemon-yellow, sometimes polished, thick or thin, pulp orange yellow, juice abundant acid, carpels 8—21, centre usually hollow :—
C. megaloxycarpa.

[*Sour Pomelo, Amilbed, Desi Kalamba of Calcutta, Keem citron.*]

* Spines usually large :—Leaves more ovate or oblong, leathery, faintly scented somewhat like the lemon, petiole more broadly winged ; fruit mostly mamillate, often deeply furrowed and warty and with folds near apex and base, rind aromatic, lemon flavoured, pulp pale lemon, coloured, with long pedicelled and subsessile vesicles, arranged in herringbone fashion in the carpels, juice abundant pure acid, carpels 12—14, centre often hollow :

[a more primitive form closer to the Pomelo proper.]

Var. *a pennivesiculata.*

[*Attarra, Siderun of Ceylon.*]

(*b*) Spines usually large ; leaves lanceolate ovate or obovate crenate, apex acute or obtuse, base obtuse or acute, of characteristic *sui generis* aroma, petioles largely winged to scarcely more than margined ; fruit subglobose with usually depressed apex to oblate, 2″—4″ smooth and polished to chagrined and deeply furrowed, orange-coloured to lobster-red, rind rather thick aromatic and often intensely bitter and pungent, pulp pale orange, sour, ocasionally slightly bitter, vesicles coarse, carpels 8—12, usually 10, centre solid : — *C. Bigaradia.*

[*Bitter orange, Seville orange, Keep of Nepal, Karna or Kanchikai of W. Coast, Nartum of Tanjore.*]

(ii)—Fruit permanently sour : leaf petiole normally naked or merely margined :—

(*a*) Spines large; leaves with faint scent, ovate elliptic or obovate, crenate or serrate, acute, obtuse or emarginate, base acute or obtuse, petiole naked or margined : fruit of two different forms, a small more or less smooth hot-weather form, and a largely developed, very warty *Dumrez* or after-rains form ; the former $2\frac{3}{4}''$—$4''$ diameter, usually maize or orange-coloured, often mamillate with folds at each end, rough or smooth elsewhere, the latter $4\frac{1}{4}''$—$5\frac{1}{2}''$ diameter, similarly coloured, very warty with highly developed mamilla, variously shaped ; rind usually thick, in *Dumrez* form, very thick, sweetish and aromatic, usually not bitter and scarcely pungent, pulp orange, sour but with flavour of the orange and not of a lemon, slightly bitter, copious ; carpels 9—13, centre solid—*C. dimorphocarpa.*

[*Khatta orange, Kharua orange of N. India.*]

* Shoots and leaves pubescent, leaf petiole sometimes slightly winged, fruit $6\frac{1}{2}''-7''$ long by $5\frac{1}{2}''-7''$ diameter, lemon yellow, sometimes polished mamillate, subwarty to lumpily knobbed and furrowed ; rind fragrant very thick, pith spongy (not carroty as in *citron*), pulp lemon or pale orange, juice abundant, carpels 13, centre hollow :—

Var *a decumana.*

[*Lahore Gulgul, Kathairee nimboo, Raskankar, Beora.*]

(*b*) Spines medium to small; leaves distinctly aromatic with characteristic lemon scent. Thin, ovate elliptic or obovate, apex acute or more usually obtuse, base obtuse, narrowed or acute, usually crenate, petioles naked or margined : fruit usually about $2''$—$2\frac{1}{2}''$ diameter, varying in shape and size, usually mamillate, lemon-coloured, somewhat chagrined, rind usually thin, characteristically

aromatic, slightly bitter, pulp pale, pure acid, aromatic, juice abundant, carpels 8—12 usually 10, centre solid or hollow :—

C. Limonum.

[*Lemon.*]

* Spines pronounced ; leaves large oblong, oblong-ovate or oblong-obovate, apex obtuse, base obtuse or narrowed, serrated ; fruit, $2\frac{3}{4}''$ diameter, deep lemon-coloured quite smooth mamillate, rind thin lemon-scented, pulp pale yellowish, juice abundant :—

Var. α *sylvestris.*

[*Wild lemon of Bareni.*]

** Spines medium to very small, shoots often hairy : leaves faintly lemon-scented, more or less oval, petioles often margined : fruit, $3''$—$4\frac{1}{2}''$ diameter, usually mamillate, sometimes depressed at apex, rind thin, juice copious :—

Var. β *decumana.*

[*Benares Gulgul, Saharanpur Gulgul, Kumaon lemon.*]

*** Spines medium ; leaves feebly scented, tough, ovate lanceolate, acute both ends or apex emarginate, serrate, petiole margined ; fruit obovoid, of a dull clayey-yellow or fawn colour, $5\frac{1}{4}''$—$10''$ diameter, mamillate or not, with folds near the stalk, rind lemon-scented, rather thick, hard and *citron* like, pulp pale, juice very sour, centre hollow :—

Var. γ *fulva.*

[*Jamiri of Allahabad and Benares, Gungollee lemon of Gonda, Behārikalān of Lucknow.*]

**** Spines very small ; leaves typically lemon leaves ; fruit $2\frac{1}{2}''$—$3\frac{1}{4}''$ diameter, almost round, sometimes mamillate, otherwise as in type :—

Var δ *Sphæro-carpa.*

[*Nepal Lemons, Napalee Kaghzinimboo, Kaghzikalān of Etawah.*]

***** Spines and leaves as in type ; fruit, $2\frac{1}{4}''$—$3\frac{1}{4}''$ diameter, usually ovoid to ellipsoid, with distinct mamilla, slightly chagrined, often with folds at either end and occasionally with furrows ; rind thin, pulp with copious pure acid, slightly aromatic juice :—

Var. ε *Limonum* proper.

[*Italian Lemon, Malta Lemon, Pondicherry Lemon, Kalān Kaghzi.*]

* * * * * * Spines and leaves unknown, fruit, ellipsoid, $2\frac{1}{2}''-3''$ diameter, mamillate and with transverse striæ on one side, otherwise smooth, lemon yellow coloured, rind thin with slight lemon flavour, pulp pale with an orange scent, juice abundant, subacid, not very sour :—

Var. β *limonaurantium.*

[*Pahari nimboo of Gonda.*]

(*c*) Spines medium to small; leaves lemon-scented, elliptic to obovate, apex usually obtuse or emarginate, base mostly acute but sometimes obtuse, crenated in the smaller and serrated in the larger; petioles yellow margined or naked: fruit $2\frac{1}{2}''-4\frac{3}{4}''$ diameter, lemon yellow coloured, usually ovoid, usually with folds at apex and base, sometimes furrowed throughout its length and slightly warted, rind rather thick, strongly lemon-scented but within white and of carroty consistence and sweetish, pulp pale lemon-like, juice very acid :—

C. limonimedica.

[*Bajouri, Bijora, Kalámba of Calcutta, Sarotee-nimboo of Gonda, Lemon citron*]

* Spines medium; leaves mostly obovate, obtuse at apex, acute or narrowed at base, petioles purplish, margined or naked; fruit, long obovoid, up to $7''$ long by $2\frac{3}{4}''$ diameter, mamillate, with folds at base, rind thick, pulp small, white dry acid :—

Var. α *Cedratiformis.*

[*Bhimra of Nepal.*]

* * Spines medium; leaves elliptic, acute or obtuse at apex, narrowed at base, serrated, petiole naked: fruit pyriform smooth pulp pale, small, very acid :—

Var. β *pyriformis.*

[*Sunkhdaren of Nepal.*]

(*d*) Spines medium, shoots often hairy; leaves oblong-elliptic, acute or obtuse at apex, acute at base, serrated

from near base, petiole naked and often not even articulated to leaf base : fruit usually ovoid, 2½″—5⅓″ diameter often 2 or 3 times as long, mamillate, lemon yellow, usually very much warted, furrowed, and striated transversely, rind very thick, aromatic, white of carroty consistence, pulp pale yellow, sour juice, scanty, carpels 10—14, usually 12 :—

C. medicolimonum.

[*Sour Citron, Citron Lemon, Turunj, Mauling of West Coast.*]

(iii) Fruits, ultimately at least, sweet or sub-acidly sweet; petioles normally winged :—

(*a*) Spines very strong on young, smaller on older, branches : shoots, pubescent or glabrous ; leaves, ovate lanceolate, acute to oblong, emarginate, serrate or entire, pubescent below or glabrous, aromatic *sui generis*, petiole usually very broadly winged ; fruit, pyriform globose or oblate, 4″—10″ diameter, usually citrine but sometimes flushed with red, rind thick, bitter and pungent and aromatic, rough with regular pimples (miliary projections) from the concavity of the oil vessels, within white and pithy adhering to the pulp ball, pulp light yellow, pink or claret coloured, sweet and aromatic, with often more or less bitterness or even acidity, carpels 8—21, usually 15—16.

C. decumana.

[*Pomalo, Pummelo, Pumelo, Pumplemose, Chakotra, Jambole.*]

[*Note.*—The four first of the following varieties are those given by Rumphius, and are, seemingly, the types from which a large number of intermediates and crosses have since been formed.]

* Spines large, subaxillary ; diminishing with age ; leaves oblong, 5″-9″by 2″-6″, obtuse and emarginate at apex, subentire, petiole largely winged 2″-3″ by 1″-2″, pubescent below ; flowers mostly four-petalled : fruit subglobose, or slightly compressed, about 9″di ameter, rind dull citrine, bitter, one inch or more thick, white

and spongy within, aromatic, pulp red or purplish-red, sweet or subacid; carpels usually 15—16, centre usually solid.

Var. α *decumana* proper.

[*Amboyna Pomelo.*]

† Fruit rather smaller, pulp white, insipid :—

Sub-variety *leuco-carpa.*

[*White Amboyna Pomelo.*]

* * Spines slender short, leaves thicker, rounder, about 7″ by 4″, more acuminate but emarginate at apex, more serrate, nerves not so distinct, petiole broad-winged, 1½″-2″ long: fruit, pyriform, about 6″ × 5″, rind citrine, bitter, 1″ thick or more; pulp redder than in last, subacid, centre hollow :—

Var. β *pyriformis.*

[*Banda Pomelo, Pear-shaped Pomelo.*]

† Fruit rather smaller, pulp white, insipid :—

Sub-variety *leuco-carpa.*

[*White Banda Pomelo, White Pear-shaped Pomelo.*]

* * * Stem taller than previous with larger crown; spines short infrequent; leaves smaller, stiffer, more glabrous; petiole resembling that of the *Seville orange:* fruit the size of a skittle ball, globose, rind thin, not very bitter, pulp white very, juicy very sweet and acidulous :—

Var. γ *pomiformis.*

Japanese Pomelo, Apple-shaped Pomelo.]

* * * * Resembles first variety, but leaves glabrous, margins not serrate, apex shortly bipid: fruit in clusters of 5 or 6, largest of all, irregular and tubercled, rind citrine, bitter and aromatic, more than 1″ thick, pulp white, more juicy and sweeter, sometimes possessed of a double rind or with secondary fully-formed pomeloes within the first :—

Var. δ *prægnans.*

[*Canton Pomelo, Jamboa.*]

* * * * * Spines and leaves not known; fruit, globose or sub-pyriform, 3¼″—4¼″ diameter, pale citrine, quite smooth rind ¼ to

½ inch thick, pulp pale like that of a lemon, subacidulous and sweet and slightly bitter, centre solid :—

Var. ε. *Palestinæ.*

[*Shaddock, Adam's apple, Pomo d' Adamo, Forbidden Fruit.*]

(*b*) Spines large ; leaves ovate or subrotrind, apex subacute or obtuse, base obtuse, crenate leathery, aromatic with the scent of *attãra* (see C. *megaloxy carpa* Var. *penni-vesiculata*) petiole broadly-winged, with crenate margins ; fruit, truncate globose or oblate, 3″—4″ diameter, pale yellow, pasty-looking, not mamillate, base sometimes with furrows and folds ; rind about ⅓ of radius, pithy and sweetish within; pulp pale orange, juice scanty, acidulous sweet, carpels 14 : flowers and fruits the whole year :—

C. semperflorens.

[*Saddphal of Benares, Saharanpur and Etawah.*]

(*iv*) Fruit at least ultimately sweet or acidulously sweet leaf petioles naked or only margined :—

(*a*) Spines medium to long, slender, shoot sparsely hairy ; leaves lemon-scented, ovate, subacute, base obtuse or narrowed ; crenate, petiole naked or margined, fruit usually quite round, sometimes ellipsoid or pyriform, mamillate or not, 2¾″—4½″ diameter, rind citrine and otherwise as a lemon, except that the pulp is quite sweet and without aroma ; Dr. Bonavia says on plate cxci, "Judging from the fruit and leaves, one would say, it is an acidless variety of the sour *Kalán-kaghzi* : judging from the flowers a lemon-coloured orange," of the Malta type :—

C. Lumia.

[*Sweet lemon, Sherbetee nimboo.*]

(*b*) Spines usually large ; flowers small but exceedingly fragrant ; leaves ovate or obovate, subacute or obtuse, sometimes notched at apex, base usually obtuse, crenate, pleasantly aromatic, petiole margined or naked ; fruit, globose or pyriform 2″—3½″; rind

smooth, pale yellow pulp acidulously sweet and pleasantly aromatic :—

C. Bergamia.

[*Bergamotte orange.*]

(*c*) Spines very small leaves faintly aromatic *sui generis*, ovate acute, base subacute or narrowed, crenate from about halfway up, petioles usually margined, but occasionally winged ; fruit more or less round, some times slightly oblate, ellipsoid or pyriform 2½"—4" diameter, usually smooth but slightly pitted all over, orange to almost claret red, rind about ⅛ of the radius aromatic with a scent something like *Lantana*, with white pith inside, pulp orange to claret or blood red, or the former streaked with the latter ; juice, copious subacidly sweet and aromatic, carpels 8—12, usually 10, centre solid :—

C. Aurantium.

[*Portugal orange, Malta orange, Blood orange* (when red within), *Mussimbi orange of Poona.*]

* Fruit ripening grass-green or citrine yellow (both just the colour of a *Pomelo*) :

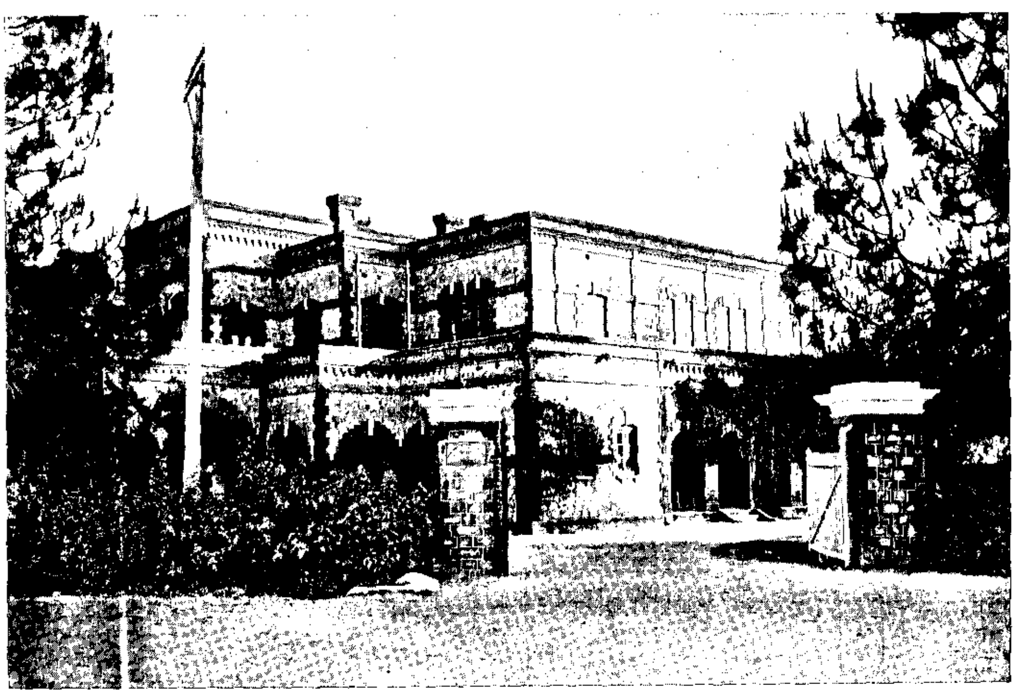
Var. *α citrina.*

[*Batavian orange of the Northern Circars.*]

(*d*) Spines rather large to rather small ; leaves lemon, scented, elliptic, subacute to obtuse at apex, base narrowed or rounded, serrate, petioles margined ; fruit, pale citron-yellow, ovoid or ellipsoid, 3¾"—6½" diameter, often twice as long, rough with miliary projections, mamillate or not, often with folds about the ends and furrows over the greater part of its length ; rind very thick, often more than half the radius, fragrantly aromatic, but not bitter, white and sweet within, with a carrot or pumpkin-like consistence ; pulp, white, dry sweetish, carpels 8—12 more or less fused, centre usually hollow :—

C. medica.

The Residence of the Principal of the I. F. College and President of the Research Institute.



The President's Office.

THE IMPERIAL FOREST COLLEGE AND RESEARCH INSTITUTE BUILDINGS AT DEHRA DUN.

[*Citron, Madhkakree, Mudhkunkur.*]

* Spines usually smaller; leaves rather more lanceolate, obtuse at apex and crenated; fruit, more or less oblong, ovoid or even pyriform, with the apical end prolonged into fingers or tails, each corresponding to the end of one or more carpels of the fruit; rind as in the last; pulp wanting:—

Var. α *digitata.*

[*Digitate citron, Fingered citron, Chhánguré, Primitive citron, of Dr. Bonavia.*]

A. W. LUSHINGTON,
Conservator of Forests.

24th May 1910.

ORIGINAL ARTICLES

ORIGINAL ARTICLES.

THE IMPERIAL FOREST COLLEGE AND RESEARCH INSTITUTE BUILDINGS AT DEHRA DUN.

[*Contributed.*]

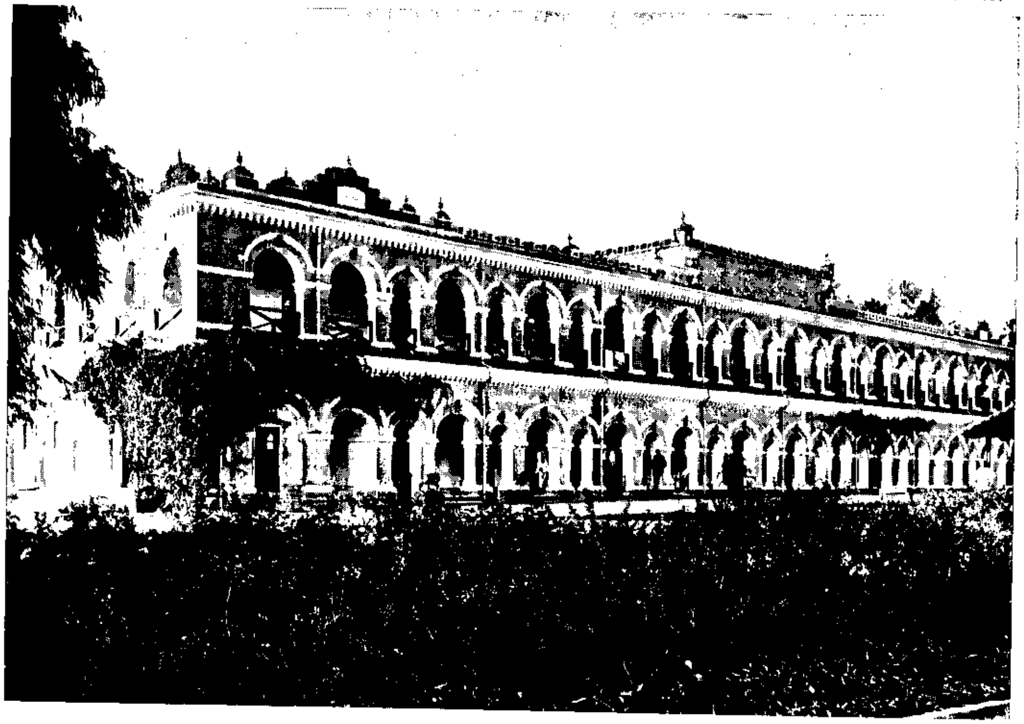
It will we think be of interest to our readers if we give a brief description of the Imperial Forest buildings at Dehra Dun illustrated by photographs. Starting with the College building,—this was purchased in the seventies by the Government of India—and the School was opened in 1878 under Colonel (then Captain) Bailey, R.E. as its first Director. The number of students was at first limited owing to somewhat restricted accommodation. In 1895 an additional block of students' double-storied quarters was erected, while Mr. Gamble when Director added two large rooms to the school house, one now used as a drawing hall and one as a museum. Our photos show the College building (Plate 13) as it now exists and the new block of double-storied quarters (Plate 15, i). There is now accommodation for 80 students and it is not proposed to increase this. Inside the College compound is a separate building used as a timber specimen museum, a curator's house, a gymnasium, four tennis courts, etc. The main building is approached by two fine avenues of *Sterculia alata*, planted by Mr. Gamble.

To the west of the College compound stands the office of the Principal and President, a fine stone double-storied building (Plate 14, ii) erected in 1900 for the offices of the old school circle. It is thoroughly well designed and is probably one of the best forest offices in India. When the school circle ceased to exist it was made over to the College and Institute. Behind this there is a carpenter's shed where furniture, etc., for the students is prepared and a fruit garden planted up with mango, lichis, loquats, etc.

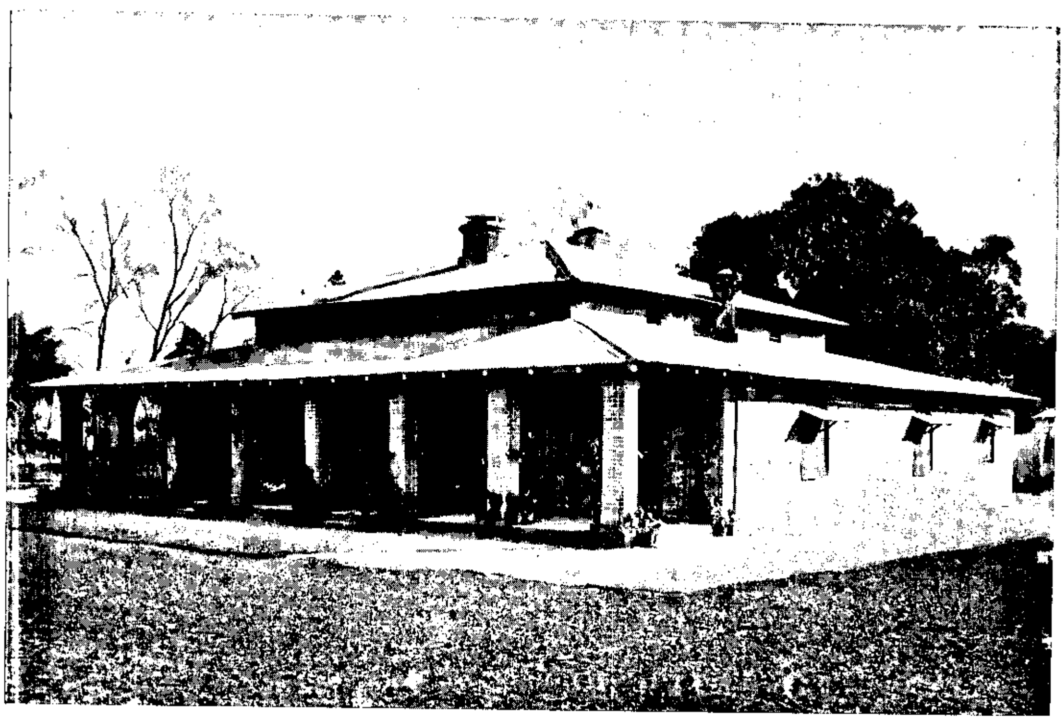
In 1893 a school hospital (Plate 17, ii) was built on a plot of ground some 500 or 600 yards from the College in the compound of the Trigonometrical Survey Offices, being made over to the Forest Department for this purpose. Fortunately it is not often required, but is as essential in the event of any infectious disease breaking out in the College. It is in charge of the Hospital Assistant attached to the College.

To the east of the College compound the Forest Department has recently acquired 5½ acres on which has been erected by the Principal a house (Plate 15, ii) substantially built of stone and brick for one of the Provincial Service Instructors, who acts as house tutor and in whose charge are the students. This is at present occupied by Mr. Wrafter; it is within some 200 yards of the double-storied block of quarters and is an essential for the maintenance of proper control and discipline.

Further west between the office of the Principal and the main Rajpur Road lies the Forest Park. This belonged to the Municipality but was looked after on its behalf by the Director. Four or five years ago it was made over to the Government of India for the purpose of erecting a house for the Deputy Director. This house was built and on the School becoming a College was given to the Principal as his official residence (Plate 14, i). The house is a double-storied one standing in the park of some 10 acres which is planted up with (principally exotic) trees. Our photo shows the north or front elevation of the house which has been considerably improved during the last two years by the present Principal. About a mile distant bordering on the Dehra cantonments stands the Chandbagh estate. This was bought some two years ago for Rs. 80,000



The Students' Quarters.



Residence of the Provincial Service Instructor.

THE IMPERIAL FOREST COLLEGE AND RESEARCH INSTITUTE BUILDINGS AT DEHRA DUN.

with the idea of furnishing residences for the Research Institute officers. On it are three houses which have been considerably improved since the purchase. One of these known as "The Chestnuts" (Plate 16, i) is in the occupation of Mr. Hole, the Forest Botanist, in another (Plate 16, ii) resides Mr. Troup, the Forest Sylviculturist, while the third (Plate 17, i) which is the largest is used as offices. In it are the offices of Messrs. Troup and Hole. This Chandbagh estate of about 17 acres is one of the finest in Dehra, and was formerly an experimental or botanical garden. All the houses on it are double-storied.

Our readers may ask why we have not a photograph of the Research Institute and why no mention of it has been made. *This has yet to be built and for this purpose an estate adjoining* Chandbagh is in course of acquisition consisting of some 16 acres. On this there is a house which will be used as offices, and adjacent to these offices will be built the Research Institute, a chemical laboratory, an insectarium with various godowns and workshops. For the acquisition of this estate and the erection of the necessary buildings the Government of India has recently sanctioned 2 lakhs. The Institute building which is of American design, *i.e.*, capable of being enlarged on all sides, is to cost about *Rs.* 1,25,000. *In it* will be museums for the sylviculturist, the economist and the entomologist, lecture rooms for the Provincial Service class which it is hoped will shortly be established, a large central library and offices for two of the Institute branches. It will be an imposing structure of stone and brick with probably a terraced roof. The chemical laboratory has been designed by the Forest Chemist *and with the insectarium* which will be somewhat similar to the one at Pusa, the workshops, etc., will complete the buildings required. We regret that we can furnish no photograph of the Institute building, but hope to do this in due course on its erection being completed. It has been designed locally by the Divisional and District Engineers.

We have recently understood from the Principal that further improvements are to be made to place the College and Institute on an up-to-date and permanent basis. *Among such will be*

the removal of the latrines outside the College compound, a tank for watering the College grounds, an extensive lavatory for students and improvement to the kitchens and dining quarters. The College building will, it is presumed, be kept for the instruction of the Ranger classes, while the Institute building, a mile away, will be utilised for the education of the Provincial Service class when this latter is inaugurated.

The proposal to build residences for the other Research Institute Officers has been dropped, as we believe the President of the Institute considers that such are for the present unnecessary, there being houses available in the vicinity. As research work progresses, and it is still in its infancy, it may be possible that more land will have to be acquired, but this is a subject for future consideration. No more land is to be at present acquired, and we agree with the President that the arrangements now made will, on the completion of the buildings, solve a question which we believe has been engaging the attention of the Government of India for some time, in the most advantageous manner possible.

FIRE CONSERVANCY IN INDIAN FORESTS.

In his article on this subject Mr. R. Sen Gupta touched on the question of the effect of fire on the soil and on the theory of toxic excretions.

As regards the first, the author makes the following statements :—" In an unprotected area the plants take the same quantity of food, *but they return nothing ;* for the fallen leaves and flowers are destroyed by the annual fires, leaving only ashes *which are a very poor substitute for the substance destroyed.*" . . . . . .
It is admitted without dispute that the soil after many years' protection is enriched. Such an admission implies that lack of protection impoverishes the soil and causes deterioration and gradual exhaustion.

We do not always, I think, make a sufficient distinction between field and forest crops. As they have obviously been selected by man on account of the nutrition contained in their

fruits, those plants which are cultivated as field crops must, originally in their wild state, have made demands on the soil greatly beyond that of the average species. In addition, by centuries of careful cultivation and selection, they have been trained to make still greater demands on the soil, and to produce fruits unnaturally swollen and rich in nutriment. Such plants are monstrosities, and when they are grown pure, as thick as the ground can hold them, it is little wonder that the soil should be exhausted and require the aid of fertilisers. But to say that primeval forests, which from primeval days have been habitually burnt over, can cause exhaustion or deterioration is, I think, unreasonable.

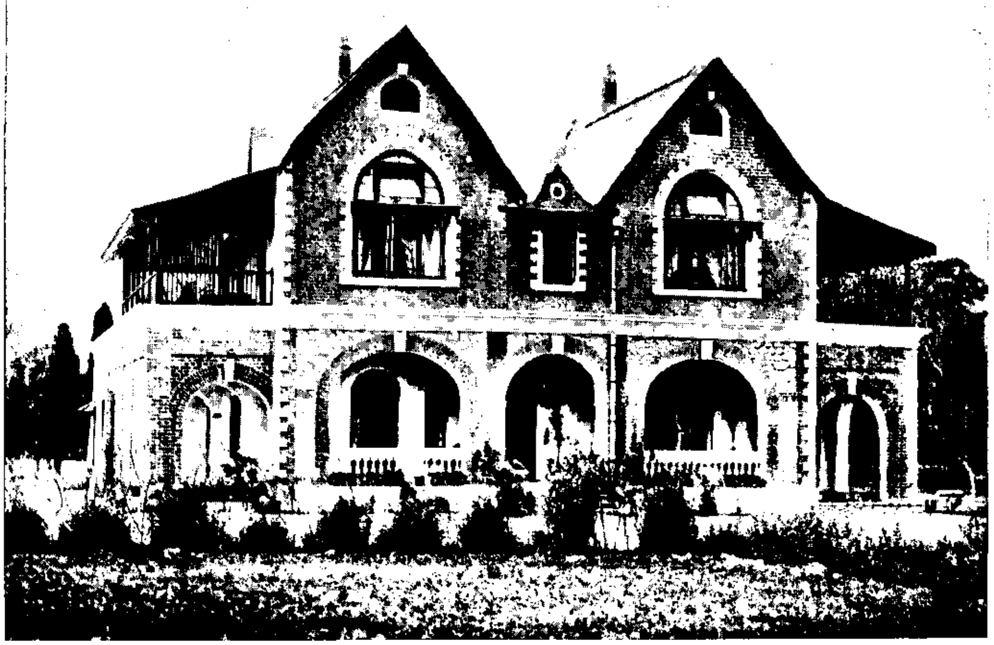
When all the leaves have fallen, and in the hot weather when they are as dry as tinder, a spark is sufficient to cause hundreds of square miles to be burnt over. The fire travels slowly, but in a deciduous forest there is nothing to stop it, until the rains break. The pernicious method of clearing a patch of jungle and burning it, Taungya cultivation as it is called in Burma, is still practised by wild tribes throughout the tropics. It is undoubtedly the most primitive method of cultivation, and has certainly descended, in unbroken sequence, from dim barbaric ages. Even before cultivation was invented, it is probable that the prehistoric man used fire to obtain fresh grass for his cattle or to drive out game. The necessary spark was therefore annually supplied, and it is practically certain that our deciduous forests have been annually burnt over not merely for the last century or so, but for hundreds of thousands of years. To my mind, however, there is still better evidence of the antiquity of annual fires in the adaptability of the 1,500 odd species found in these forests, to withstand fire. In Europe I cannot recall a single species which is in any way capable of resisting fire. In America, I believe, one or two species offer some slight resistance to fire, but in our deciduous forests large numbers of trees, unless worn out by old age or suppression are more or less fireproof.

If therefore the nutriment drawn up by plants and distributed among the leaves were actually destroyed when the leaves fell to

the ground and were burnt, or even if an infinitesimal amount were destroyed *annually*, in the course of centuries and ages the accumulated effect would be so great, that however great the supply in the ground may have been originally, not a particle would remain, and as a result the growth would be miserable and stunted. The reverse is the case, at any rate in Burma.

We say that leaves are destroyed by fire, but this is merely for the sake of convenience. Substance is never destroyed, and when leaves are burnt the bulk of the substance merely disappears from our sight. Mr. Gupta says that "trees take no less than 50 per cent of the substance (carbon) from the atmosphere, and about 48 per cent. (hydrogen and oxygen) from the water in the soil, and the remaining 2 per cent. only (nitrogen and ash) directly from the soil. When leaves are burnt there is a most charming instance of the saying "a place for everything and everything in its place." The potassium, calcium, magnesium, iron, phosphorus, sodium, manganese, silicon and chlorine, the ashes in fact of which Mr. Gupta writes so disrespectfully, are all returned immediately to the soil from whence they came; the carbon is ready in a convenient form to be re-assimilated. The next monsoon brings back the oxygen and hydrogen; and the first few thunderstorms at the break of the rains are impregnated with nitrous acid. Fire therefore distributes the whole of the substance in the most convenient manner for future crops. The only possible difficulty appears to be the question of nitrogen. However, as the result of experiments at Rothampstead, it has been discovered that when soil is heated, the amount of nitrogen is increased. It has also been shown by experiment in India that the increased fertility due to *Rab* is due, not so much to the ashes but rather to the heating of the soil. It has been suggested that the nitrogenous fixing bacteria, notably azotobacter are less affected by the heat than the phagocytes. It is the principle that what is injurious to the individual, may be beneficial to the species as a whole, and is analogous to the case of teak and annual fires in Burma. The azotobacter are temporarily overcome, but soon pull themselves together, and gain a great advantage in the struggle for existence

The "Chestnuts", the residence of the Imperial Forest Botanist.



The residence of the Imperial Superintendent ef Forest Working Plans.

THE IMPERIAL FOREST COLLEGE AND RESEARCH INSTITUTE BUILDINGS
AT DEHRA DUN.

by the fact that the animalculæ of prey suffer still more heavily. The experiments now being carried on at Pusa and elsewhere may throw some more light on the subject. In any case, however, whether this theory is correct or not, forest crops do not require a large amount of nitrogen, and I know of no reason for thinking that in an unprotected area they cannot obtain sufficient.

When oxygen, hydrogen, nitrogen, and carbon start playing together, they are capable of all sorts of surprises, and it is possible that the process of decomposition or consumption by insects may give rise to some luscious combination, highly appreciated by plants. So far as my own experience goes, however, I am inclined to think that only a very small proportion of the leaves is devoured by insects and that the disappearance of the leaves in protected areas is due to very rapid decomposition, the effect of which is, I believe, practically identical with that of combustion.

Weighing the *pros* and *cons*, therefore, I am inclined to think that in respect of the chemical effect, the balance is in favour of unprotected areas, since the soil benefits by the heating and by the exposure and consequent aeration. I have, however, no decided opinions either way, and merely make these few comments as a protest against the general practice of slurring the matter over with the gratuitous assumption that the deterioration of the soil in unprotected areas is beyond dispute.

The other point on which I wish to make a few remarks is the theory, on which so much stress is laid by Mr. Gupta, that plants excrete a toxic substance which is responsible for the absence of natural regeneration. Although this theory would explain several difficulties, I confess I am unable to swallow it, as it seems to me so pointedly foolish for any plant to indulge in such a suicidal policy. Although death usually results to a bee through inability to extract the offending member, one can understand the gradual evolution of the sting of a bee, because it benefits the whole community; but any plant which deliberately emitted poisons injurious to its own offspring and to no other, would, I think, be fated to, and deserve extinction, and it is impossible to understand how such a habit could have been evolved by

natural selection. The toxin is supposed to be easily broken down by any other species which, in a short time, renders the soil wholesome again, and I think most advocates of this theory only claim that the excretions necessitate a rotation of crops. But in most Indian forests there is what may be called a "simultaneous rotation of crops" and it is reasonable to suppose that the poisonous excretion of one species would be counteracted by the sweetness of its competitors. On this theory the social plants present a considerable difficulty. I do not know whether bamboos, for instance, are supposed to practise the same unpleasant habits as Sal and *Macaranga denticulata*, but a gregarious bamboo, such as *Bambusa polymorpha*, which has ample opportunity thoroughly to impregnate the soil, would be in a very bad way. This bamboo indulges in one grand bout of reproduction, about once a century and dies with the effort, and if the regeneration suffered harm, the species would become extinct.

Mr. Gupta states that Sal seedlings begin to die in the middle of August. If death were due to toxin in the soil, it would occur immediately after germination, in June, as soon as the rootlets were developed ; and, on the other hand, as the toxin is soluble in water, the poison would be so diluted and weak by the middle and end of the rains, that the death-rate would decrease. A simpler explanation would be that the seedlings suffer from the lack of aeration of the soil or that they are water-logged.

My greatest objection to the theory is, however, that although toxicology has been brought to a great pitch of perfection, yet the actual presence of any poison in the soil has not been proved by chemical tests. Until this is done, I think we should consider this view a plausible explanation of difficulties rather than a satisfactory and well established theory.

The present tendency is to jump to conclusions, and I have therefore selected these two points to illustrate the desirability of cultivating more exact habits of thought and of suspending judgment until more evidence is available.

RANGOON : }
May 1910. }

H. S. WALKER.

SHIKAR, TRAVEL, AND NATURAL HISTORY NOTES.

THE KHEDDAH DRIVES IN MYSORE.

It is customary in the Mysore State for the Maharajah to hold an elephant drive during each Viceroyalty; and the drives in Lord Minto's honour were held in November last at Kakenkote.

Mr. F. A. Lodge and myself were by the kindness of His Highness invited not only to be present during the Viceroy's visit, but to spend some days watching the preliminary operations in the field.

Few have had the opportunity of seeing this most interesting portion of the work and as no account of it usually appears in the papers, the following note may prove of some interest.

Kakenkote is a small forest station on the Kabbani river near the western boundary of the Mysore State. South, west and north stretch the unending forests of the Western Ghats along which herds of elephants wander with some approach to a regular seasonal migration.

Towards the end of the year the general movement is westwards towards the heavy forests of Coorg. Kakenkote not only lies on the direct route, but owing to the conformation of the country and a wedge of cultivation running into the forest from the east, is a point at which the line of migration is naturally constricted into narrow limits. The river also with its steep left bank makes it much easier than it otherwise would be to control the movements of the herds.

There are in other respects few facilities for carrying out extensive operations. Local labour there is practically none, and all material has to be imported.

The preliminary arrangements for the drives are therefore of a very extensive nature and occupied the entire attention of Mr. M. Muthanna, Rai Bahadur, the Head of the Forest Service in Mysore, and his staff for several months in advance.

Mr. Muthanna was well known to many of us Madras foresters when District Forest Officer of Bellary.

The first steps were to open a local bazaar and arrange for food supplies for the hundreds of coolies imported from other parts of the State. A hospital was also built and accommodation provided for the local forest officers and police.

During August, September and October immense quantities of timber for the stockades were brought in, and fire wood and fodder stacked, as, in the interests of the teak forests round Kakenkote, no local timber was used.

The river bank had also to be escarped for several miles and three bridges thrown over the unfordable Kabbani. Many miles of drive line were also cleared and trenches dug. Lastly, special arrangements had to be made for the accommodation of the Dacca establishment. Most of this work fell on the shoulders of the assistant conservator Mr. Govinda Rao.

The Bengali party in charge of assistant superintendent Oosumeah, consisting of 5 jemadars, 25 mahouts and 222 hunters, arrived towards the end of October and immediately undertook the completion of the stockade building, at which they are experts.

While all these works were in progress the State shikaries and forest watchers were out in the forest gathering information as to the number and movements of the various herds ; and by the beginning of November Mr. Muthanna was in a position to prepare a general scheme of operations.

Before describing the actual drives a few remarks are called for on the general method adopted.

When a herd of elephants is first located, care is taken not to disturb it more than can be helped. The practice is to gently push it forward in the desired direction by the occasional appearance of a tracker. This part of the work requires great skill, especially when it is desired to collect together small scattered herds ; and the carelessness of a single shikari may upset the results of several days' work.

Only picked jungle men are used during the early stages under the guidance of the forest officers.

The first surrounds are very wide and it is not until the elephants have entered the forest in the river loop opposite Kakenkote that any serious attempt is made to force them. From the hill called Ainpur-betta, the celebrated Sanderson cut many years ago the radiating forcing lines shown on the map which play so important a part in all the Kheddah operations.

Once within the cleared lines forcing is practicable as a large number of men can be more or less permanently kept on the spot and supplied with provisions from the central bazaar at Mastigudi. The lines are ordinarily held by a couple of men at every 30 yards. One man is always on the watch and keeps a fire burning on each side. His companion sleeps, cooks, or collects fire-wood and grass.

When the surround is contracted the intervals diminish until there is practically a continuous line of fire from end to end. The surrounds are under the supervision of an assistant conservator assisted by the assistant superintendent of Kheddahs and his jemadars. The assistant conservator visits the whole surround at least once by day and again by night. The lines are controlled by the forest rangers who have under them foresters and forest guards in charge of shorter lengths. They are expected to patrol their lines once by day and twice by night.

No one may leave his post in the surround without the permission of the officer in charge, but when the elephants are quiet in the middle of the day some of the watchers are told off to bring up water and supplies.

When it is realized that in the intervals of forcing the lines have sometimes to be held for 10 days the strain on the men and the hardship of sleeping out in the jungle night after night may be imagined.

For the final drives men are often called in from other work such as stockade building, pumping, and the hundred and one jobs going on round the Kheddahs; and there may be as many as 1,000 men on the ground in the closing stages, though usually about 600 suffice.

The lead is usually taken by the Bengali hunters, many of whom are armed with guns.

The elephants when they have been driven for some distance advance very unwillingly and take advantage of every piece of cover to stop and evade the beaters.

Night or late in the evening is the time usually adopted for driving, as the herds move more freely then, and fire can be used to better advantage.

There does not appear to be any great danger in most of the drives provided the beaters support each other, as these trained men almost invariably do. The chief difficulty is to maintain an unbroken line in heavy forest.

When closing in on the Kheddah the danger increases and it is very difficult at times to move the elephants forward; but the operation is greatly helped by previously piling large quantities of dry grass on the line to be taken. These are fired one after another with the result that the herd is driven forward by a ring of fire from behind.

Fire is in fact the chief agent throughout. All stop lines are held by fires; there are fires round the Kheddah stockades after capture, and along the river bank; and one of the most undesirable, but luckily rare, occurrences during the operations is a storm of rain.

The Kheddah enclosures are about 5 to 10 acres in extent surrounded by a trench 5 feet deep and 4 feet wide on the outer edge of which is a timber stockade. The latter is made of small jungle timber bound together with coir rope and though insufficient in itself to permanently retain a herd is a sufficient defence to enable the watchers to prevent an elephant digging his way across the trench.

The drop gate is made of steel rails suspended from a wooden frame and released by a catch which is manipulated by a responsible man on an adjacent machan.

The herd once driven into the Kheddah is left alone until the time arrives to rope the elephants. They are supplied with water from the river by a pump and large quantities of fodder are thrown into the Kheddah daily.

The roping stockade into which the elephants are ultimately driven from the Kheddah enclosure is about 30 feet in diameter

and very strongly built. The driving of the herd from the enclosure into the former is probably the most dangerous business connected with the whole operation, as the elephants have become used to the presence of human beings and have to some extent lost their fear. It is chiefly carried out by the Kumaki elephants, behind whom the beaters can obtain some protection.

The Kumaki elephants follow the wild ones into the roping kraal and for two or three hours push and knock about the captures into as complete a state of exhaustion and bewilderment as they are capable of. The larger captures are then singled out and pushed backwards against the stockade to which the shikaries secure their hind legs by ropes. They are left in this position until the smaller elephants have been lassoed round the neck and dragged out, when they in turn are taken out to the elephant camp up stream.

The process of roping is not a pretty sight and one wonders how the calves ever survive it; but it is very interesting to watch, especially when a big elephant has to be tackled, the even-tempered and business-like behaviour of the Burmese Kumakis who pound and butt the captures with much vigour but no malice.

To return to the operations themselves. On the 1st of November, a large herd had arrived in the Begur forests near Mudikibida-Volkere. It was evidently intent on moving westwards, and by the evening of the 2nd November the Calicut-Mysore high road was accordingly blocked for nearly 9 miles from Machur to Kharapur and all traffic stopped. Arrangements for the surround were rapidly made but the herd shifted its ground during the night and crossed the Kabbani into the Kakenkote forests. During the following day surrounds were posted on the Naihalla and Kurchikaduvu lines radiating from Ainpurbetta (Sanderson's hill) and the lines on the road and left bank of the river to the west strengthened. On the 4th the drive commenced and although a portion of the herd broke back the greater number were forced to recross the river into the triangle formed by the above surround lines and the right bank of the Kabbani.

The herd was retained in this position until the 9th when the long Mastigudi line was posted, the Naihalla line broken up, and

the elephants forced northwards across the Kurchikaduvu line along the right bank of the Kabbani to bring them into position opposite the Kheddah. On the 10th a further contraction of the surround took place; the Kurchikaduvu line being broken, and the more northern Kalikattakaduvu line being held.

At night on the 11th the final drive took place. The river both up stream and down was held by a line of Kumaki elephants *drawn across the stream, the mahouts on which carried torches.* The beaters and surrounds on the Mastigudi and Kalikattakaduvu lines closed in and by the aid of fire lines and bundles of dried grass, previously placed on the line of drive, gradually forced the herd, though with great difficulty, into the river somewhat above the Kheddah entrance on the opposite bank.

A capture was now practically assured. The whole of the steep left bank of the Kabbani had been escarped and further strengthened by a stockade along its top. The herd was unable to break up or down stream owing to the two lines of Kumakis; and unless it broke back by the right bank, which was now a line of blazing fire and shouting beaters, it had to find a retreat by the one accessible ascent on the left bank, an ascent which led direct into the stockade. By 10-30 P.M. the whole herd was successfully captured.

In the meantime the trackers had located several small herds of elephants in the forests to the north of Kakenkote and were keeping them under observation. Mr. Mascurenhas, the Kakenkote ranger, after a personal examination of the ground reported that he believed that they could be captured. The difficulties were great as the permanent drive lines were useless. It is also for some reason or other extremely difficult to drive elephants towards Kakenkote from the north; probably because the direction is opposed to their line of November migration. The herds too were small and much separated, and a very fine solitary tusker was certain to give trouble in the surround.

However Mr. Muthanna determined to make the attempt, and on the 13th he sent out the whole of the Bengali hunters and a large number of local men. It was thought that the elephants were certain to break westwards. On the east was open country and cultivation.

The most important line was therefore that from Mastigudi to Sunkadakatta, some seven miles long. To clear and hold this line required an immense number of men and there was some delay in obtaining additional help. The only other line at first considered necessary was one along the Antarsante-Sunkadakatta road, but when the drive began it was found necessary to supplement this with a third line along the forest boundary to the east.

On the 16th the elephants had been driven as far as the north bank of the Hebbaka stream but all attempts to force them over it in the direction of Kakenkote failed. Some of them broke away altogether, including the big tusker, and the greatest difficulty was found in retaining the herds.

On the 17th the lines were strengthened and reformed, the Sundapur cart-track held to the east of the Hebbaka Nala, and men also posted along the main road to Mysore. The elephants however escaped out of the surround during the night over the Sundapur cart-track and the whole business had to be begun again.

The herds which had now become more or less consolidated, were tracked and again located by Mr. Mascurenhas on the following day, and in the meantime the assistant conservator, Mr. G. Krishnamoorthi Naidu, and Ranger Appiah arrived with more assistance.

On the night of the 18th the herd was again surrounded and forced back westwards on the 19th over the cart-track and across the temporary line held on the 16th. Both these lines were then strongly posted. On the 20th the elephants were given no rest and were driven southwards over the Udabur cart-track.

As the lines contracted the difficulty of holding the elephants should have decreased, but it was found very difficult to move them from the vicinity of the Shigur tank.

A great effort was made on the 21st night and in the early hours of the morning the outer surround line of No. 2 Kheddah was crossed.

It was hoped to complete the drive on the 22nd but all attempts to move the herd towards the Kheddah failed and on two

occasions it broke through the lines and the surrounds had to be re-formed.

It was now doubtful whether the elephants would ever be captured as the men, who had been on their tracks night and day since the 12th, were thoroughly exhausted; but Mr. Muthanna determined to make a final effort on the 23rd.

Additional fire lines were cut, dry grass stored, more labour provided, and every possible precaution taken against the elephants breaking back. The final attempt began at 3 P.M., on the 23rd, a very unusual hour; but the elephants were already thoroughly frightened and no advantage was to by gained by waiting for nightfall when the organization could not be so thoroughly supervised.

Mr. Lodge and myself were fortunate enough to arrive in time to see the final struggle. Accompanied by Mr. Muthanna, we took up our position in a machan close to the drop gate. The beat began at 3-30 when the herd was about ¼ mile from the Kheddah entrance.

The first advance appeared comparatively rapid, but there was a long delay in forcing the elephants over the final fire line. This line was not more than 100 yards from the Kheddah gate to which converged on one side a deep trench and on the other a palisade and side line held by massed beaters.

No elephant will willingly be driven over a cleared line, and this final fire line, with its heaps of dry grass ready to ignite, was probably more than usually frightening. The firing of blank charges, bugle calls, noise of clappers, and shouting was incessant and nerve shaking, and whenever a pause occurred we thought the elephants had broken back. At last however smoke rose; the elephants had crossed, and the success of the drive seemed assured.

The din increased every moment and some of the beaters appeared but we could still see nothing of the elephants. Under our machan was a big bamboo clump and round this clump came at last a seething, writhing, indiscriminate black mass of elephants blind with terror, those on the outside pushing wildly into the ruck.

Round and round the clump they went with the beaters within 15 yards of them and it seemed as if the mass would never advance. Finally a female stepped across the opening in front of us and the writhing mass slowly unwound itself and followed her at a shuffle. Four elephants rushed through the gate. The next, an old female with her temper up, charged the gate post as she entered and down came the 30 cwt. iron gate.

This was an anti-climax with a vengeance! There were now some 40 elephants within the space of a good sized ball room unable to go forward and practically forced to go back.

The beaters fled for their lives through the stockade or jumped the trench and it did not appear that order would ever be restored from the pandemonium that ensued. Luckily the elephants were more bewildered than the men. Rapid orders were given by the Conservator to reform a line some 100 yards back, and the manner in which the officers in charge stopped the beaters from howling and beating their breasts, reorganized them and rushed them back to reform, was altogether admirable. They were not in time to mass in sufficient strength to prevent a determined rush by some six elephants which, headed by a tusker, were altogether irresistible.

In the meantime Mr. Muthaya the head State shikari in charge of the drop, finding it impossible to move the fallen iron gate, at considerable risk to himself cut away the stockade between the end of the trench and the gate post, leaving just sufficient breadth for an elephant to squeeze through.

Being almost dark and a case of neck or nothing, it was determined after a short rest to try and force the elephants one by one through this opening. The proceeding seemed an impossibility, but the beaters were mad with excitement; and success was in the end achieved.

While the closing stage lasted it was the most exciting scene imaginable. The elephants, especially the females with calves, charged repeatedly and were met with blank and shot cartridges, fire, sticks and stones from distances of a few yards; and an altogether infernal noise from the beaters. No one was actually hurt, except in a few cases by gun-shot wounds.

The failure of any elephant to get home was due to the plucky way the beaters supported each other when charged, and to the fear which elephants have of fire in any form. One old elephant picked her unfortunate little calf out of the trench into which it had fallen in the turmoil and carried it through the opening in her trunk.

The closing of the entrance and the capture of the herd was followed by a scene of general congratulation ; but I have never seen more exhausted specimens of humanity than the beaters. Most of them had had little or no sleep for several days and the officers in charge were completely worn out.

The third drive was designed for the Viceroy's visit. A herd had been located on the 18th at Malkotehadi in a very convenient locality not far from Sanderson's Hill. The surround was rapidly made but owing to the progress of the second drive, Mr. Muthanna was very short handed and the river side had to be left unguarded. This was crossed by the herd at night but instead of breaking away eastwards they luckily doubled back over the river and were found on the 20th near Sanderson's Hill. Before they could be surrounded the herd took fright and moved off rapidly. A few Kurumbers were sent ahead to endeavour to check them, a function which they successfully performed by keeping to the tree tops and making the most of their small numbers until the shikaris and beaters arrived. The herd was then driven back over the Naihalla line and held by posting the latter and the Mastigudi line until Drive No. 2 was over.

Thereafter the surround was gradually contracted in the usual manner until November 28th when His Highness the Maharajah and his guests arrived from Mysore. On the morning of that day the herd was driven into a small area on the river bank opposite Kheddah No. 3 and held by a large force of beaters. It was intended that it should be forced into the river a quarter of a mile above the Viceroy's stand on the opposite bank. The river being blocked above, the elephants would then have worked their way down the left bank trying to find an exit and would have passed immediately under the visitors' stand on the river bank.

The drive however began somewhat early and had to be stopped when a few of the elephants had already shown themselves on the opposite bank. In the pause which ensued they moved down the river and when on the Viceroy's arrival the drive recommenced they swam across below the Viceroy's stand exactly opposite the entrance of the Kheddah, which they entered at once. It was then almost dark. All we saw was a dark mass take the water with a heavy splash, and within 10 minutes we were hurrying to see the captures in the Kheddah. In fact as the Dewan remarked the whole proceeding was so clever that it was almost uninteresting.

The following days were spent driving the elephants from the Kheddah to the roping kraals and in roping the captures and leading them off to the camp at Kakenkote.

So much has been written about this part of the operations that I will not add to it.

There are a few points of interest I will however mention in conclusion.

The total number of elephants caught was, I think, about ninety. When I left they had not all been roped and it is impossible to be sure of their number in the Kheddahs. The prize of the drives was an immense tusker with a single tusk taken in the first Kheddah, which put up a tremendous fight in the roping kraal. Unfortunately he lost one of his eyes in the process from a spear wound. This elephant was considerably larger than any of the fine Burma tuskers, and it took no less than seven of the latter to drag him from the roping kraal to the camp.

There were several fine young tuskers among the captures, but the larger number were cows and calves.

As a rule the elephants after roping were remarkably quiet and subdued ; and the most troublesome were usually the bachchas. The latter had apparently a terrible time in the roping kraals, but their bodies and minds seemed equally elastic and they suffered no real injury.

I should mention that the third drive had a special interest of its own. The surrounds were held and the operations conducted almost entirely by the local forest people without the help of the

Bengali hunters. The herd also instead of being driven into the usual Kheddah enclosure was driven directly into a roping kraal and within five minutes of capture was subject to the view of all the visitors who occupied a gallery running round the top of the kraals and watched the elephants under the light of torches.

An interesting feature of this year's operations was also the abandonment of the old system of tying captives to trees in the forests. This had the great drawback of causing considerable mortality from rupture and great injury to the feet and legs, while the difficulty of daily watering so many untamed elephants in the river was almost insuperable. On this occasion rows of single kraals were built for the reception of captives which were put into them as fast as the kraals were constructed.

Mr. Lodge had a specimen kraal from Begur forest station carried in and erected for the Maharajah's inspection, into which the big tusker was ultimately put. Although made of teak baulks 16″ square and driven six feet into the ground, the tusker made the whole kraal rock with his charges. In these kraals the elephants are freed from ropes and cannot seriously injure themselves. Unlimited water supplied from the river by a steam-pump is laid on by pipes to troughs outside each kraal; and plantain leaves, fodder, sugar-cane, are daily brought in immense quantities. I hear the captives are all doing excellently and that there has been no mortality. They will undoubtedly fetch much higher prices than before.

My account would not be complete without mention of the Viceroy's camp at Kharapur, where electric-lit tents and every conceivable comfort including a fleet of Whitesteam-cars to run backwards and forwards to and from the Kheddahs, made it impossible to realize one was in the jungle.

The most lasting impression left by the visit is in fact the enormous trouble taken to make the drives a success and the kindness and hospitality we met on every side.

The whole operations were wonderfully organized.

S. COX,
District Forest Officer, The Nilgiris.

MORTALITY OF CHEETAL (*CERVUS AXIS*) FROM RINDERPEST.

About ten days ago a sportsman who had been shooting in one of the blocks of this Division informed me that a virulent epidemic disease had broken out among the cheetal in the block for which he had a permit, and a few days later I received reports from my subordinates that cheetal were dying off by the score.

Yesterday I marched to a bungalow in one of the infected blocks and just before reaching the house I found the skeletons of some half-a-dozen cheetal hinds lying in the bed of the stream which flows past the rest-house, and since then I have seen the remains of some two or three dozen more cheetal and some sambhar and barking deer lying about in various parts of the forest.

In some places they have died in groups of five or six. My cursory examination shows that the epidemic has been a very severe one, while my subordinates assure me that it has been spread over a wide stretch of forest and that hundreds of animals have died within the last three weeks.

At noon to-day a cheetal stag came into the forest depôt and staggered into the hut of a bamboo contractor, where it collapsed, and was promptly killed by the occupants of the hut.

The poor brute was evidently *in extremis* and appeared to be making for water.

The cattle in these forests have been suffering from rinderpest for some months, and it seems as if the deer family had contracted the disease by feeding on the grass which had been tainted by diseased cattle.

So far the only animals which are known to have succumbed to the epidemic are cheetal, sambhar, nilgái and barking deer.

A noticeable fact in this connection is the sudden disappearance of tigers and panthers from the blocks in which the epidemic has been raging.

As the case is rather a remarkable one it may be worth recording.

GANGES DIVISION, U. P.
May 22nd, 1910.

B. A. REBSCH.

THE GAME PRESERVES OF ASSAM.

It is only within the last five years that any attention has been given to the preservation of big game in Assam. There are three sanctuaries in the Kamrup district and one each at Lukwah and Kasaranga in the Nowgong district. The remaining districts are left almost unprotected. With the exception of game in these sanctuaries, which are reserved for rhino-breeding, almost everything in the whole province is indiscriminately slaughtered. The game in Kamrup reserves is increasing, but it will take years to undo all the harm done. It is painful to think that the Viceroy's inroad into one special rhino reserve resulted in a bag of only one cow-rhino, where, twenty years ago, in and around this same spot fifty could be seen.

On the south bank of the Brahmaputra there are still a few breeding places left, but these are inaccessible till about April, after the jungle has been burnt off. The Government reserved forests in these parts can hardly boast of a rhino outside the areas. Their homes and feeding grounds are between the lower ranges at the foot of the Mekir and Garo Hills, in the low-lying swamps and dollonies, covered with dense ekra and kagri, almost as thick as bamboos, growing to a height of from 15 to 20 feet, through which it is impossible to drive a hathi at the pace a rhino travels through it. There are very few shikaries who will attempt tracking them on foot through these runs, and when they do, it invariably ends in disaster. The writer has known many good old cautious trackers who have had to pay the "extreme penalty" for attempting to follow up a rhino in these death-traps. Only four months ago Major Wood had the misfortune to lose an old shikari in one of these attempts, and nearly lost his life in trying to save the man. The incident occurred in the Bisnath district, and was one of the pluckiest attempts to save a man's life that has been heard of for a long time.

The Forest Officer of Kamrup and Darrang districts, who prepared and conducted the shoot for the Viceroy, is the only man known in the whole valley who takes a keen interest and strictly enforces the Government rules and regulations on big game. The

man that is doing all the damage and driving rhino and tiger from their old breeding places is the Nepali and his kutia. Government allow these kutias to be erected and allow these men to bring in their large herds of buffalo who roam about at their own sweet will over every well-known breeding spot in Assam—grazing and hacking down the best covers in the province. And for this Government taxes them Re. 1 per head of buffalo. It can be truthfully said where one is paid for fifty get off scot-free. Every sportsman in Assam is aware that more harm has been done by these Nepali exterminators within these last eight years than has been done by shikar since tea was first started. Unless Government keep these outlaws within certain bounds, there will not be a head of big game left in Assam in a short time. The Mungledye Sub-division of Darrang, from Borpeta to Tezpur on the north bank, provides excellent sport for almost every kind of game, big and small; and no hard-or-fast rules or restrictions are made except in three or four small reserves which rhino are known to breed. These spots are the only places that get any special attention paid them to save the game on the north bank from extinction. Due north from Mungledye to the end of North Lakhimpur, on the borders of the Arka, Duphla, and Sarogmiri Hills, there is splendid Mithan shooting up the Karan, Belsiri, Borelli, Dekorai, Borgang, Derjoo, Ranganadi, Derpai, and Subansiri rivers, the latter being the largest feeder in the valley to the Brahmaputra. The finest mahseer fishing in India can be got up the Subansiri from the end of October to the end of March. Some of the pools in this river, even in the dry season, are nearly 1,000 yards across, and the fish in these pools run up to 80lbs. and over. On or near the banks of all these streams herds of Mithan are to be found where salt poongs abound, and on several churs of the Brahmaputra tiger, leopard, and bear, etc., are sure to be found. And in the oloo grass and bheels around some fine bags of duck, partridge, snipe, and florican are to be had. Perhaps the finest sport for a varied bag of both big and small game on the north bank is between the Gierborelli and the Subansiri. The grounds, as a rule, are easy to shoot over, and often the unexpected turns up

and gives likelier chances to bag a fine specimen than in any other part of Assam of which we know. And the country from October to April is free to all, bar a few small forest reserves, and every facility is afforded and every help rendered to any keen outside sportsman by the hospitable planter. If a man has the time, a visit to the Daphlas over the border may result in some real good sport in the way of wild goat, sheep, gurral, etc., and he might possibly bag a hathi, while in all the places mentioned above numerous herds of wild buffalo are still to be found, and it is safe to reckon on getting a decent head. On the south bank in the Lakhimpur and Sibsagur districts, however, big game is almost extinct, and no measure of preservation is resorted to in the case of what little is left. Some hundreds of gun licenses have been granted indiscriminately to all sorts and conditions of natives, who have wantonly destroyed everything they could lay their hands upon regardless of the most ordinary principles of sport which should appeal even to this class of native shikari. Concrete instances of this departure from the excepted amenities of sport may be cited in numerous cases of the native big game hunter killing new-born calves in breeding and closed time. We are, however, glad to learn that the Deputy Commissioners in these districts are realising these facts and are confiscating every gun and cancelling licenses whenever they get the slightest possible chance of doing so.—(*Statesman.*)

THE DANKEI TIGRESS

THE DANKEI TIGRESS.

The day's work was done, and I was sitting reading in front of my tent when a note was brought to me that had just come in from a brother officer, who happened to be encamped about eighteen miles away. His note ran that he had wounded a tiger the day before, and that it was lying up in a "shindi-band," *i.e.*, wild date (*Phœnix sylvestris*) grove, near his camp. Would I come over and give him a helping hand? I at once called up my shikari and told him to go on with the guns as soon as he could, and that I would follow in the morning. Accordingly, early next day I got on to my horse and started off to give what aid I could to my

comrade. I got to his camp a little after eight o'clock, and found him ready to receive me. My men had arrived, and so he knew that I was coming. He very soon put me *au courant* as to the details of the matter in hand. The tiger had been doing a good deal of damage in the neighbourhood, killing cattle, and making itself generally objectionable. Two days before it had been marked down and he had got a shot and hit, but the brute had managed to get away and hide in a nearly impenetrable grove of wild dates not far from his camp.

Before proceeding with the main story, a curious incident merits relation. My friend had given strict orders, after having wounded the tiger, that no one was to go under any circumstances into the shindi-band. Now from the juice of the date palm an intoxicating drink, "toddy" ("shindi" in the vernacular) is produced, and a toddy drawer had gone early in the morning as usual, in defiance of the warning given, to draw this toddy from the trees in the grove in which the wounded tiger was skulking. An incision is made in the bark sufficiently deep to tap the sap, and an earthen vessel, called a "madka," is placed over the incision to receive the resultant fluid. The toddy drawer, then, had gone into the date grove, regardless of the risk, and got busy collecting his madkas. In order to do this he had to climb the trees, and while he was up one, inspecting the pot fastened on to it, the wounded animal suddenly made its appearance at the foot. It remained there for some time—a couple of hours, according to the wretched toddy drawer's own story; anyway, it remained long enough to frighten the man to death, for, incredible as it may appear to be, he, after relating his adventure, lay down and was dead in a couple of hours, although he had not received a scratch or bodily harm of any sort.

My friend and I made up our plan of campaign in consultation with our two shikaris. Buffaloes are said to possess extremely penetrative powers of scenting a tiger, and if there be any number of them in company they will charge down in a body and drive away any animal of the kind they may come across. We accordingly determined to send a herd of about 100 buffaloes into the

shindi-band, with some twenty-five men to drive them. Strict injunctions were issued that on no account was any driver to loiter or get separated from the herd or from his companions. The herd was to be driven from one end of the date grove, while my friend and I were to take up our positions at the other. The grove was not wide—not more than forty yards at the broadest part—but it was very dense, heavy undergrowth, and the overhead shade was sufficient to make the interior quite dark, more particularly so when compared with the radiant brilliancy caused by the sun's glare outside. We took up our places on two trees at the end of the grove, facing one another, and not more than from twenty-five to thirty paces apart. Our spare gun bearers got up into the trees with us, and the beat began. On came the buffaloes and their drivers, slowly and steadily, and—passed us! This was surprising; the tiger must have moved away, or else the buffaloes must surely have winded it. We began to get down from our perches, and the first man to touch the ground was my friend's spare gun bearer. On the instant, like a flash, a huge beast rushed out of the semi-darkness, dashed by, dealing the man one tremendous buffet in passing, and was lost again in the depths of the shindi-band. It was something perfectly indescribable; a rush, a blow, and—gone! Neither my friend nor I had time to fire; we were in the act of descending from our places and could not possibly have done so. The poor fellow who had had the bad luck to be the first to touch the ground presented a gruesome sight; his head was literally stove in—utterly smashed with just one blow of that mighty paw; death was instantaneous.

This was very unpleasant and very unexpected. My friend and I and the remaining gun bearer got away from the near vicinity of the shindi-band as soon as we possibly could, and then we proceeded to hold a council of war. Evidently the yarns about buffaloes smelling out tigers were all moonshine; anyway, our buffaloes had not detected our tiger. We concluded that it had been driven to the edge of the grove and had there lain low, afraid to face the open after its previous and recent experience. Probably the buffaloes and the row and confusion generally had upset its

equanimity, and as it had been wounded by my friend, it was altogether in a very bad temper, which it had wreaked upon the unfortunate gun-bearer. What should be done now? We decided to go back to the village and hold a consultation.

Arrived at the village, the first thing we did was to muster the beaters and have a roll call, and—precisely what we half feared and fully expected—one man was missing. We wanted to go back and look for him, but nothing on earth would induce the villagers to face the shindi-band again, and small blame to them; they were utterly defenceless but for hatchets and cudgels. There happened, however, to be a small party of police stationed in the village. These men were armed with old-fashioned muskets, and they volunteered to come with us; so back we went, my friend and I and about half a dozen policemen. When we got to the date grove we set fire to the grass, and under cover of this we cautiously advanced, guns at full cock and every sense on the alert. After going in some little distance, seventy-five yards or so, we came on the object of our search—an object in more ways than one. The stupid fellow, evidently ignoring the strict orders given, had loitered behind, and the tiger must have met him on its way back after striking down the gun-bearer. We picked the poor man up and carried him off, and then, collecting the slaughtered gun-bearer on our way, retraced our steps to camp.

There was a Government elephant at the headquarters of the district, some forty miles or so away, and we decided to requisition the services of this animal. I could not stay for the sequel, as I had to return to my work, but my friend got the beast three days afterwards. When it reached his camp he mounted it and went into the shindi-band, and after a little search found the tigress—for it was a female—dead, and in a very advanced stage of decomposition. The shot which he had fired when he first turned her out had proved fatal; it was very well placed, just behind the shoulder, and it is extraordinary that the brute did not succumb under it sooner than she did. However, strange things do occur, and this was one of them; the Dankei tigress died game.—(*By D.F O. in the Field.*)

A GHASTLY ENCOUNTER WITH A PANTHER.

It was about 7 at night, some ten months ago, in the Punjab; we were just sitting to dinner when there arrived quite out of breath a "Goojur" belonging to a village about five miles away. He told me that at sunset a panther had come and carried away a young calf in the presence of the cowherd, and that he had seen it enter a ravine, where he was sure it was still concealed with its quarry. I was all too eager to meet this formidable beast, to hesitate an instant; dinner was left untouched and a rush was made at once to my shooting irons, which were my trusty .303 and Bull-dog 5-shooter, notwithstanding the representations of several who wished to detain me, by offering a hundred and one obstacles regarding the darkness of the night, bad weather, etc., etc.; but knowing, as I did, that the moon rose at 10 P.M. and that I ought to be alongside of Master Spots before that hour, I started. I saddled my noble charger "Nero" and mounting, hailed the "Goojur," who in his endeavour to take a "Bee-line," went along narrow tracks, and often through the bush. My hunting-knife knocked against my legs and stuck in the branches; so to avoid collisions I secured it out of harm's way. On reaching the spot indicated by my guide, I found the villagers waiting for me. For a "draw" they had got ready a sheep and a huge peg to attach it to. They led me a short distance round, to the outside of a large nullah, where they pulled up and pointed to where the beast lay. They placed me at the coign of vantage, promising to go round and tether the lure. The ground, where I was fixed up was on a falling gradient, which descended by a somewhat steep slope to the nullah, or ravine, on the edge of which I took my stand to conquer or to die. The good old "Goojur" drove in the stake in the higher ground, about 15 or 20 yards from me and there tethered the sheep, as a goat was not very handy, and I thought that a sheep being a timid creature would bleet the more. I had rested myself in the thicket and had not drawn my hunting knife from its sheath nor my revolver from its holster, to lay them on the ground, so as to have them handy, when separating the slender twigs which might impede its movements, quicker then lightning the marauder

fell upon the bait. I held my breath, and hesitated firing, hoping the moon would afford me a gleam of light; a delay of some seconds thus ensued, for its rays only occasionally showed through the dark flitting clouds. But what was my astonishment to see the panther passing by me, carrying off the sheep with the ease of a terrier carrying off a rat! It was about 10 yards from me, and moving directly across, I could neither distinguish head nor tail, only a blurred mass. The remembrance of my 29 unsuccessful nights flashed across my mind; impatience carried me completely away, and, forgetting all prudent resolutions, I opened fire. My ·303 was loaded with 95 grs. of powder and 20 slugs. The object of my aim fell, uttering ghastly moans, at the same time dropping the sheep. I had broken the panther's two fore legs; yet it had not seen from whence the shot came; and for aught I know, might have thought that the sheep had exploded in its jaws. The slightest movement on my part would be certain to attract attention, common-sense demanded that the most complete immobility should be observed; but, fearing a surprise, I determined to stand up in my hiding-place to see over it, and be the better prepared for results. In rising, a branch caught the top of my coat and shook it a bit. This was another of the providential chances to which I owe my life. The wily brute now alarmed, did not utter a cry, or a sound, but fixed its attention on the thicket and listened. A few moments passed, and I, hearing and seeing nothing, thought the monster dead. Crouching and using every precaution I issued from my shelter, carrying my piece with the barrels lowered and my finger on the second trigger. As soon as I was seen, the panther made a spring of quite 10 feet towards me. I aimed at its head; but the rapidity of its spring was so great, and the darkness so intense, that I missed, my ball entering the ground, and the fire from my piece singeing the hair in its neck. The terrible beast now threw itself upon me, and bore me to mother earth in an instant. I dropped underneath on my back, with my shoulders caught up in the bush, that had served as a place of concealment. First the dreadful creature attempted to strangle me, and fixing upon my neck, tore at it in indescribable rage. This was luckily protected by the

collar and thick hood of my coat. With both my hands I convulsively grasped my assailant by the neck. It then seized me across the face, and driving its formidable teeth into the flesh, almost smashed my jaw, which it certainly would have done, had I not at the onset smashed both his fore paws. The noise thus caused sounded so painfully, that I thought my brains were being squeezed out. My face was in its mouth, from whence issued a burning, fetid breath that stifled me. Still I clung to the foe by the neck, which was as large and hard as the trunk of a tree, and at length, with the strength of despair, I was enabled to thrust away its terrible head from mine. It then seized me by the left arm, and bit me through the elbow ; without the large amount of clothing with which it was covered, it must have been crushed like a piece of glass. The panther tried a second time to take me by the face, I resisted, but my strength was all but exhausted. Making a movement to better my condition, it clutched my head. Gathering all the strength and determination that yet remained for a final effort, I disengaged myself, leaving my wadded cloth case in its jaws. I had thrown the brute from me so vigorously that it slipped over the steep slope ; the two front paws being broken, it could not check itself but went crashing headlong, roaring into the "nallah." At last released, I relieved myself by spitting out four of my teeth and a mass of blood that filled my mouth. Just then the villagers came up and seeing my tattered face and gory condition carried me home, where my friends who had seen me start in the pink of condition were not a little surprised at my mangled state. My left cheek was torn and lay in my mouth and my face was a mass of blood. At my desire a doctor friend of mine was sent for in whom I had entire confidence. Those who surrounded me were very sad, and less composed than myself. I read in their faces that they thought me a dead man, but I tried to reassure them, by telling them that the heart was still sound and cheerful. Previous to this I had often said that the happiest day of my life would be that on which armed only with my hunting knife, I should encounter a panther or leopard, so much did I reckon on the vigour of my arm. Notwithstanding the providential chance that placed me on the

slippery side of the ravine, and notwithstanding the other favourable circumstances that protected me, if my late foe had not been deprived of the use of his fore feet, I must have been lost.

The panther was subsequently killed, and under the careful management and care of my doctor friend I recovered in about four months, though I still carry the scars of that never-to-be-forgotten struggle.—(*By Nikola in the Indian Field.*)

A BIRD OBSERVATORY.

In that corner of the Baltic Sea where sand dunes and pine reign supreme along the coast, there are several large sheets of fresh water, known locally by the name of "Haff," which are only separated from the open sea by a narrow strip of sand, barely one half mile in width at the broadest part, but varying in length from fifty to sometimes one hundred miles or more. It is at Rossitten, a small fishing village, on one of these sand belts, called the Kurische Nehrung, that there is situated what is perhaps the most interesting of all bird-observing stations in the world—namely, the official observatory of the German Ornithological Society as the title, "Vogelwarte," would imply.

When winter has relaxed its grip upon Northern Europe, and when green foliage and grass begin to replace the snow and ice, a continual stream of summer residents pours in from the South in the shape of birds of all species and sizes, from the warblers to the eagles and storks, all on their way to breed in comparative safety in the Tundras, the swamps of Finland, or in the vast forest regions of Northern Russia, some remaining of course, distributed over Eastern Prussia and Lithuania. The reason has yet to be discovered why these winged travellers from Southern Europe should select the Kurische Nehrung, that long isthmus of sand, year after year, as their exclusive line of flight in this particular region, for a really satisfactory explanation, is not as yet forthcoming.

Director Thienemann, who is in charge of the observatory, if I may style it thus, hit upon a very ingenious plan some years ago, in order to ascertain as accurately as possible, the directions resumed

by the birds after they had passed over the Kurische Nehrung, for, strange as it may seem, just as suddenly as they concentrate from the whole of Central or Northern Europe upon reaching the Nehrung, just as suddenly do they disperse upon leaving it, each little party going its own way. At first, Director Thienemann caught several hundred of the constantly passing hoodie crows, put rings with a registered number and the words " Vogelwarte Rossitten " on their legs, and set them free to continue their journey unmolested, at the same time carefully recording against each number, the date and conditions of capture and subsequent liberation. Most of the ornithological and sporting journals of the European continent published these doings, and latterly some of our own publications have contained notices referring to these rings, and, as might be expected some extremely interesting results have ensued, not only with marked crows, but also with ringed storks and Kittiwake gulls and even a dunlin.

The storks hold the record for distance as authenticated reports have reached us telling of marked birds being captured by natives and others in Natal, Cape Colony, and the Transvaal, which show us their winter quarters, whilst some migrating storks with rings were shot in Calabria (Italy), and also by Arabs in the Syrian desert near Damascus. The hoodie crows from the Baltic confine their excursions in winter to the Rhine districts, and occasionally to the North of France, whereas in summer they prefer the forests of Lithuania and Northern Russia where they breed. Kittiwake gulls hatched out at Rossitten wander during the winter months to Tunis, and Italy, and France, some of them finding Lyons a very pleasant resort when the Baltic Haffs are sealed by ice Finally, a little winter visitor a dunlin, from Eastern Europe, found his way to the Essex marshes in the month of December last, and finding the weather open he stayed, but was shot and his ring bore evidence of the fact that Director Thienemann had registered him when passing the observatory on the 3rd August 1909. Now it must not be supposed by bird lovers that we advocate or even desire marked birds killed for the sake of their rings ; on the contrary, it is the earnest wish of the Director that it be left entirely

to chance whether a ringed bird be captured or not, but, of course, should anyone hear of such a capture, he will be facilitating these experiments by sending intimation.

Whatever be the sense that guides a small bird like the redstart, and permits of a journey from the Nile Valley to the Nehrung perhaps in a single spring night, it is, and ever will remain a marvellous sight to witness upon any favourable day in spring or autumn, flight after flight, flock upon flock, of every kind of feathered migrant pass that narrow strip of sand dunes at Rossitten. Often there is barely an hour's interval between two separate flights, and yet, behold! the newcomers choose their line over identically the same patch of marram grass as their predecessors, now out of sight and many miles ahead. Nor will even a gunshot deter the birds from using their chosen line of flight, which varies for each particular day according to the weather conditions, because sometimes the "passage" takes place above the range of human vision; at others the birds will fly barely a foot from the ground, and it is then that the poor inhabitants of the fishing villages on the Nehrung take a heavy toll of the crows especially by stretching fall nets across their path.

Director Thienemann employs a stuffed owl to attract passing birds of prey, knowing how irresistible this is to the kites and falcons. With a wild swoop they flash down from the heavens, only to be met with a charge of the concealed watcher's gun. But their numbers are legion, for peregrines travel in the wake of the finches, and on a single day one can see hoodie crows, carrion crows, buzzards and eagles intermingled with their erstwhile victims, and followed by redshanks, ruffs, phalaropes, and wildfowl, to say nothing of the larks close upon the tails of the sparrowhawks. Some idea of the myriads may be had when one hears that a lighthouse-keeper records the capture of 13,000 larks upon one single stormy night in November.—(" *W.D. M.*" *in Pall Mall Gazette.*)

BAGASSE FOR PAPER.

BY WILLIAM RAITT.

Bagasse or megass, the refuse crushed sugar-canes or chips from the diffusion batteries, has come into some degree of prominence of late as a possible raw material for paper. It may, therefore, be useful to consider, from the collective experience available, modified or confirmed by our own, how far the hopes held out regarding it in some quarters are likely to be justified. The growing scarcity of wood-pulp in Europe and America is giving occasion for a great amount of research and experiment with the object of finding a suitable substitute, and while several have been suggested which combine all the advantages necessary to a commercial as well as a technical success, it is to be feared that an insufficient acquaintance with the scientific and economic problems evolved, has resulted in others being brought forward which hold out very little prospect of practical usefulness.

It may be as well, first, to enquire as to what grade or class of raw material is wanted in supplement of, or in substitution for, wood-pulp. For this purpose, paper may be broadly divided into three main grades, corresponding fairly accurately with the principal divisions of the raw material market :—

(1) The best qualities of writing-paper,—manufactured almost wholly from linen and cotton rag.

(2) Inferior writing-paper, book printing and newspaper,—manufactured mainly from wood-pulp.

(3) Coarse unbleached paper, wrapping and packing paper,—manufactured from textile wastes, old sacking, and such like materials.

Now, the growing demand for a new material arises solely from No. 2. Since rag is now reserved almost exclusively for No. 1, the supply is quite adequate to the demand, and, apart from this,

no other material is likely to be found which, at the same cost, combines the necessary requirements of strength and colour. For No. 3, where strength only is required, the market is also fully supplied, and the steady development of textile industries, with the resultant continual increase in the output of wastes, seems likely to keep it so. But although the new demand is confined to No. 2, it represents about 75 per cent of the whole, and at present uses up about six million tons per annum, so that there is plenty of scope for a material suitable for it. In this case, suitability means that it be bleachable at a low cost.

Bagasse contains about 50 per cent of available cellulose. Our own investigations of it have yielded from 46 to 50 per cent, and with a comparatively mild soda treatment, it could be depended on to give, in mill practice, an average yield of 45 per cent of air-dry unbleached cellulose or pulp. So far, it appears to fill the bill, but there is more than that that goes to the making of a good pulp for No. 2 class.

With all fibre-yielding plants, there is a point or period of growth at which the fibre is at its best, not only in quantity and quality, but (what is of serious importance to the paper-maker) in uniformity of its qualities throughout the whole plant. The pulp to be produced must be of uniform quality, and this cannot be got if there are serious differences in the nature of the raw material as between one part and another of the plant. With plants grown primarily for fibre, a period can generally be fixed on for cutting at which the fibre is at its best not only in strength and colour, but also in uniformity throughout the whole plant. But with cultivation primarily for other uses, the case is very different. Generally, when fibre only is wanted, the plant is at its best when fully mature, *but not ripe*. Where fruit or seed is the chief object, the mature stage of the fibre is passed ; where *juice* is wanted, it has not been reached.

The stage at which sugar-cane holds its maximum saccharine contents appears to coincide with a state of partial and irregular maturity of the fibre. While the fibres on the outside, or just under the skin of the cane are firm, long and of good strength

though somewhat harsh, those from the interior are short and weak. It therefore presents the most difficult of problems to the paper-maker. Since the chemical treatment must be uniform, it follows that it must be severe enough to reduce the outer fibres completely, thereby largely destroying the inner ones, or it must be mild enough to conserve the latter and leave the former only partially resolved into pulp. In the first case, the yield is largely reduced, and what remains is expensive to bleach, because the severity of the treatment has degraded the weaker fibres into insoluble brown compounds which stain the pulp. In the latter case, the yield is good, but the product is almost equally difficult to bleach satisfactorily, because of the admixture of partially digested outer fibre. The pulp is consequently full of specks and blotches, unfit for anything but the commonest of bleached paper, and that only in conjunction with some better and more uniform material.

This feature of bagasse explains the wide differences in yield reported by various experimenters,—those using the severe treatment getting as low as 25 per cent. Our own preference is for the method which gives the largest yield irrespective of bleaching qualities, since by neither process is the bleaching satisfactory either in efficiency or cost. This opinion is reinforced by the fact that the larger yield is obtainable at a lesser cost for soda, and, further, by the technical difficulties and cost of bleaching in the tropics with imported chemicals. It must, however, be conceded that in no department of chemical technology is progress more hopeful than in this, and it is quite possible that we may see a considerable improvement in bleaching processes during the next few years.

We do not think, then, that bagasse can be seriously considered as a candidate for class 2, but there are localities in which it may find a very profitable entrance into class 3.

Cane sugar factories are usually situated in localities where all manufactured goods have to be imported at a considerable cost for freight, and, probably, import duties also. Where such circumstances exist, together with a sufficient local demand for unbleached wrapping and packing papers, or even for the thin unbleached

paper so largely used by the natives of India and elsewhere for correspondence and accounts, it is quite possible to show that a paper-mill may prove a very profitable auxiliary to a sugar factory, and that the bagasse may be worth considerably more for this purpose than its present fuel value.

A paper-mill suitable for this class of paper, to produce 40 to 50 tons per week, would cost roughly £20,000. A conservative estimate of the cost of production, under average conditions exclusive of the fuel value of the bagasse but including repairs, depreciation and 5 per cent interest on cost of plant, amounts to £10 10*s*. per ton. Under the conditions above referred to, the product should be worth £15, leaving £4 10*s*. as the paper making value of the 2¼ tons of bagasse required to produce it, or say, £2 per ton. The cost of steam coal to replace it in the sugar factory furnaces would be at the outside £1 10*s*. per ton. In calorific effect a ton of good steam coal is usually. assumed to be equal to 4 tons of bagasse, so that the full value of the latter cannot exceed seven shillings and six pence per ton. Deducting this, there remains an estimated profit of £1 12*s*. 6*d*. per ton of bagasse converted into paper.—(*Tropical Agriculturist.*)

POISONOUS HONEY.

Illness, and even death, are sometimes caused by eating natural honey, free from all adulterations, says Professor Karl Sajo. The Professor is not aware that any fatal cases of poisoning have occurred in Europe. They are reported exclusively from America and Asia. Almost all cases are caused by the use of honey derived from the flowers of plants of the Alpine rose and heath families (*Rhodoraceæ* and *Ericaceæ*). The matter is somewhat puzzling, because cases of severe poisoning are very rare. For example, the American cases, which are attributed to *Kalmaia angustifolia and K. latifolia*, are only two in number, although these plants are common in America. Even in Europe, illness is sometimes produced by eating honey. I have myself witnessed several mild cases, one of which appears to throw some light upon

the subject. Some children, who were watching their teacher cleaning a honey-comb asked him the nature of the dark and acrid paste with which some of the cells were filled. The teacher explained that this was bee-bread. The children asked if it was fit to eat, and the teacher carelessly answered, "yes". The children ate the bee-bread freely, despite its unpleasant taste, and all became extremely ill.

The reader doubtless knows that bees fill certain cells partly with pollen, which is necessary food for the development of the young bees, as it contains albumenoids, while honey contains only carbohydrates. This pollen is known as bee-bread. It is usually stored in certain special groups of cells, which can be easily separated from the honey cells. Sometimes, however, the bee-keeper, to his disgust, finds in the honeycomb, intermingled with the honey cells, many cells which contain pollen. Often the lower part of a cell is filled with pollen, and the upper part with honey. In the case above cited, the poisoning was evidently due to the pollen, for persons who ate the honey from which the bee-bread had been removed experienced no ill effects. I know, from personal experience, that the eating of honey-comb which contains bee bread often produces unpleasant symptoms and loss of appetite.

Several possibilities suggest themselves. The pollen may be naturally poisonous, for many pollen grains contain toxines, as was proved by Professor Dunbar in his investigation of the cause of hay fever. It is possible, also, that the pollen stored in the cells may become decomposed, and thus produce disease germs and poisonous substances. If the bees wish to preserve their stores of pollen which are not usually protected by large additions of honey, they are obliged to add large quantities of a secretion containing formic acid and it is not impossible that, in this operation, large doses of the alkaline poison of their stings may also be added.

In view of these facts, it appears probable that the cases of poisoning attributed to honey are really caused by pollen. If this is true, the frequency of such cases should be diminished by modern methods of bee-keeping, in which a compartment of the hive s reserved exclusively for honey, and the bee-bread is

almost entirely deposited in cells attached to the brood comb, in another compartment. Furthermore, honey is now seldom pressed from the comb, but is almost entirely extracted by centrifugal separators, in which the semi-liquid honey flows out of the cells, leaving the more solid bee bread behind. In the case of honey in the comb, the presence of bee-bread cells is easily detected by inspection or by the taste, and a little care in removing them will prevent any evil consequences.—(*Indian Trade Journal.*)

Photo.-Mechl. Dept., Thomason College, Roorkee.

Photos by T. Salisbury Woolsey Jr.

A New Resin Cup.

ORIGINAL ARTICLES.

A NEW RESIN CUP.

Quite recently a new resin cup has been invented, which bids fair to revolutionise the collection of resin. The following system is used: Two holes from three quarters to one inch in

Photo.-Mechl. Dept., Thomason College, Roorkee.

Photos by T. Salisbury Woolsey Jr.

A New Resin Cup

diameter are bored into the sap of the tree at a tangent with the heart wood. These holes start from the same place and extend in depth about five inches, but vary according to the diameter of the tree. A patent auger is then used to prepare a place for the attachment of the metal cap, which is fastened snugly over the hole and then nailed in place. The glass cup is locked into the cap and the cup ready for operation. It is claimed that the cup will fill up in from thirty-six hours to two months, according to the grade of timber and the weather conditions. Moreover the grade of gum produced is far superior to any secured under the old system, since there is no evaporation and no dirt of any kind can get into the sap.

Perhaps the most important claim is that the tree is unharmed by this method of tapping and that the timber can be worked for a great many years. Plates 18 and 19 clearly illustrate its operation.

Plate 18 (*i*).—The junction of the two 1-inch auger holes that gather and conduct the gum from the tree are clearly illustrated. These holes on this tree are about five inches deep.

Plate 18 (*ii*).—The patent cutter has been used to prepare the tree for the attachment of the cap shown in figures 3 and 4. The ring is four inches in diameter and is about ¼ inch deep. It is just deep enough to prevent the water from getting under the cap and to give it a firm hold. It does not reach the sap wood and hence there is no injury to the tree.

Plate 19 (*i*).—The cup is moved every four months up and to one side. This figure illustrates the possibility of placing a number of cups on a large tree. After the cup is removed the holes are stopped up with clay and soon heel over, although the scar left would undoubtedly damage a small portion of the final output of lumber.

Plate 19 (*ii*).—These cups have been in operation three hours and yet are nearly full of a fine grade of gum. Careful scrutiny will disclose the gum dropping into the cups from the spouts.

The writer feels that in view of the turpentine experiments in Chir pine in the Himalaya Mountains that the foregoing system would be of great interest to the Indian Forest Service.

This new invention will be experimented with, and, if successful, can undoubtedly be applied on all national forests where the turpentine industry is possible. The Supervisor of the Choctawhatchee National Forest in Florida supplied the photographs and information used in this note.

T. SALISBURY WOOLSEY, JR.

THE POWELL WOOD PROCESS COMPANY, (INDIA), LIMITED.

As is well known this company commenced erecting a powellising plant at the end of 1908, but it was not fully completed for ten months afterwards. There were some miscalculations in the requirements owing to the plant being the first of its kind in India, which considerably protracted the time of completion, but it is expected that three months would be sufficient to build similar plants in future.

The present plant consists of two processing vats 42 ft. long and one 17 ft. long heated by a 40 H. P. Lancashire boiler. The drying room is 80 ft. long by 18 ft. wide, and steam for this is supplied by a smaller, Britannia type, boiler. The plant can turn out about 500 tons of sleepers a month, or a rather smaller quantity of scantlings.

Much attention has been directed by the company to obtaining suitable timber for treatment—and thanks to the interest shown by forest officers and their attention in forwarding samples—it has been possible to powellise specimens of most of the Indian timbers. The result has been to show that a large number of Indian woods at present little used may be converted by powellising into timber of considerable commercial value.

The present cost however of even the most inferior kinds of Indian woods prevents the company from putting the powellised article on the market with much hope of success; this is mainly due to the heavy charges of railing to Bombay, and another difficulty is the length of time contractors require to deliver

timber in any quantity, for which at present there is not much demand.

To successfully treat Indian woods on the most economical scale, it would appear that plants will have to be erected at the various sources of supply, and this is no doubt, what will be done when the success of the process is assured.

The company have so far turned their attention more particularly to woods from Burma and Singapore which can be delivered in Bombay at moderate rates. A large quantity of these scantlings have been successfully treated, and there is every prospect of obtaining a good demand for them in the near future.

There would seem to be a great future in store for powellised sleepers and it is expected that several of the railways of India will soon be placing orders for them. The selection of cheap and suitable woods is one of great importance and can only be arrived at by trial. There are now ten different kinds of Indian woods under observation on a permanent way in Burma and the last report regarding these was highly satisfactory, the information to be obtained from this trial is most valuable. Other trials being carried out in India and various parts of the world leave little doubt as to the immunity of powellised wood from the attacks of rot and white ants.

The progress of the Indian company is slow compared to the rapid strides being made by the companies in Australasia, as will be seen from an article which appeared in the '*West Australian* of 5th January 1910. In this article it is stated that the Commissioner of Railways has agreed that all timber used in the railway systems of the Western States shall be powellised. The company in New South Wales puts through about one million super feet of timber a year, and this is used for railway sleepers, wood paving and the finest cabinet work, and so forth. In New Zealand they put through a similar amount and have just concluded an agreement with the Government there to change their creosoting plant into a powellising plant.'

The conditions of climate in India are even more favourable for the process than in Australia, and in a few years it may be

expected to extend to the same proportions that it has done in that country.

G. C. PHILLIPS.

BOMBAY:
12th May 1910.

[*Extracts from the "West Australian," dated 5th January* 1910.]

The method of powellising sleepers at the works at Bunbury is thus explained by Mr. Gorton :—"As the sleepers are received straight from the mills they are run in steel trucks into huge vats, which are then hermetically sealed at both ends. A cold solution of molasses and other ingredients is then turned into the vat, and the temperature of the whole gradually raised to boiling point, *viz.*, 214° Fahr. The temperature is maintained in that way for some hours, the length of time depending on the size and nature of the timber being treated. In raising the temperature the air in the wood expands and a large proportion forces itself out and escapes into the solution in a series of bubbles. The boiling point of the saccharine solution is two or three degrees above that of water and the moisture or sap which is the home of all fungoid growths in the wood is thus converted into steam, which escapes with the air, carrying with it much of the colouring and other matter in the sap. When the evolution of air and steam ceases as shown by the cessation of rising bubbles, the boiling is stopped and the solution allowed to cool slowly, and in this process it is absorbed into the wood penetrating every portion of it, and thus replacing the previously expelled sap and air. The timber is removed when the solution is cold, and if it is required to be seasoned, is placed in special drying chambers, where its moisture contents can be reduced if required to less than 1 per cent of the dry weight of the wood substance proper. Once the timber has been stacked on the trucks it need never be handled again until it is sent along the wharf for transhipment to the steamers."

"With regard to the seasoning of timber," said Mr. Gorton, "it has been found in practice that within 14 days the moisture

contents of our Australian hardwoods after treatment can be and have been reduced from 60 per cent to 3 per cent of the dry weight of the wood itself; not that such a low moisture percentage is either requisite or desirable. It is impossible to naturally season any timber to that extent, 7 per cent being practically the lowest record obtained in the Western Australian tests, with even small sticks after a great number of years stacking."

"We have an agreement with your Commissioner of Railways," continued Mr. Gorton, "by which all timber used in the railway systems of the State shall be powellised. Our company in New South Wales puts through something like one million feet of timber a month, and this is used for railway sleepers, wood paving and the finest cabinet-making, and so forth. In New Zealand we put through much the same amount and have just concluded an agreement with the Government there to change all their creosoting plant in to powellising plant. I expect that before long we shall be establishing our own works in Western Australia irrespective of those which may be erected by the Government."

During the course of his remarks Mr. Gorton produced several Government Lithograph Department photographs, showing side by side specimens of treated and non-treated timber after they had been submitted to numerous severe tests. In every case the non-treated woods were either riddled with white ants or rotted by fungus or damp, whilst the powellised timber presented as sound an appearance as when first treated some years before. There were also standing in the company's office logs of jarrah and karri, and those which had been treated showed scarcely any sign of deterioration whatsoever, whereas those which had been allowed to dry naturally had split and warped so as to become practically useless.

ON THE SELECTION OF THE REPRESENTATIVE RADIUS.

To prepare a working plan it is necessary to ascertain the rate of growth of the species dealt with, and in most of the recent plans in Burma this has been done for teak by counting the annual

rings along a radius marked at intervals corresponding to the girths, the rate of growth between which it is desired to ascertain. But the choice of the radius presents difficulties perhaps not obvious at first sight.

The object in view is to select a radius which shall throughout its length show a series of annual rings truly representative of the tree's average rate of growth at the various stages of its life.

Two opinions have been held, the first that the radius selected must bear a constant proportion to the size of the tree for all trees and the second that each tree should be considered separately (on its own merits) and that radius chosen which to the observer appears most truly representative.

The objections to this latter method of selection are that considerable skill and experience are necessary on the part of the observer, and that there is much room for individual error. Not only do different observer's ideas of what is a representative radius vary, but assuming they have the same ideas their judgment will not be of the same quality. The personal equation enters too much into the decision. On the other hand, if the radius chosen bears a constant proportion to the size of the tree, there is little room for personal idiosyncrasies, and in the case of a large number of trees a truer average is probably obtained. Any system, however, prescribing a definite exact length for the radius, ties the observer down so much. In practice it is probable that only two or three and perhaps only one radius of the prescribed length will be found, and all these may be unsuitable for counting rings owing to a defect in the timber or for other reasons.

But if we decide to adopt this method of selection, it remains to decide what proportion the radius chosen shall bear to the size of the tree. We wish to find the radius of the circle whose area is equal to the basal area of the tree. This is nothing more than the old problem of how to determine the volume of a log. Experience has shown that the best way of calculating the area of a tree-section is to take the arithmetic mean of the maximum and minimum diameters, to assume that the section is circular, and that this is its diameter. Half the arithmetic mean between the

major and minor axes of a stump seems then the best way of getting at the radius we are seeking.

Other possible radii are $\frac{\text{circumference}}{2\pi}$, $\sqrt{ab}$, $\frac{2ab}{a+b}$, where 2a and 2b are the major and minor axes.

Of these, the first is true only when the tree has a perfectly circular section, and for all other cases gives too long a radius; $\sqrt{ab}$, the geometric mean between the two half-diameters, is correct when the tree is elliptic in section, and would probably be better than the arithmetic mean. It is, however, not so easy to work out a square root in the field as an arithmetic mean, and the excess error made by taking $\frac{a+b}{2}$, instead of $\sqrt{ab}$ does not exceed 7 per cent unless the tree is so irregular in shape as to have its minimum diameter less than half its greatest thickness. $\frac{2ab}{a+b}$, the harmonic mean, appears to be no better than the arithmetic or the geometric mean for practical work, and gives rather too small a radius if we assume trees to be approximately elliptic in section.

In practice I found that it was extremely difficult to count rings whatever method I adopted. The uniformity found in most Burma working plans on the rate of growth of teak in the natural forest is astonishing, and one cannot help questioning whether there may not be some fault at the base of our methods vitiating the value of the results obtained. Measurements on marked trees in the forest, so far as these have gone, seem not to substantiate working plan estimates of growth, but rather tend to show that the latter are generally too sanguine.

"OP."

SHIKAR, TRAVEL, AND NATURAL HISTORY NOTES.

A GOOD DAY WITH GAUR IN BURMA.

The gaur (or miscalled bison of the Indian shikari) is, without doubt, the finest species of the Bos tribe, and is naturally one of the most highly prized of all big game which can fall to the sportsman's rifle. The pursuit of the gaur leads one through the most magnificent country, uphill and down dale (no slope appears to be too steep for them), along valleys and streams, through majestic teak forests, and on into the darkest interiors of the thickest jungles. As with all big game shooting, it is only by much hard work and perseverance that one can hope for success with bison. Often, after having followed the track since daybreak, one has to give up the chase on account of the failing light; or, again, a whole

day may be spent without one coming across any tracks, except perhaps a few old ones. But the most cruel luck of all is just as one is getting up to the herd, or solitary bull, as the case may be, after hours of careful tracking, to hear a tremendous crashing of branches and stampeding of feet, telling that the animals are off in full gallop, which probably means a still longer spell of strenuous work and patient tracking for the shikari, although in most cases, where a herd has been disturbed (especially if they have been much shot at before) the odds are that the bison will put more distance between themselves and the shikari than the latter can cover in the day.

The day described here was a very fortunate one, for it is not often that one has the luck to kill two bison in the same day. It was, in fact, the only day in a whole month's shooting leave in which I fired any shots.

It was decided on one particular night that we should, as usual go out next day separately, E. V. W. to the south and I to the south-west, both in the same directions in which we had been that day. Although the jungle was very thick we both of us had come across fairly fresh tracks, and altogether this ground looked far more promising than the country in which we had been three or four days previously.

We were all up early the following morning, and I, accompanied by three Burmans (one a really good tracker) and E.V.W., who also had three very good men with him, started off, after having had our "chota hazri" in the dark. It was before sunrise that I was over the near ridge and in the low valley beyond, which was where we hoped to find bison tracks. As soon as we were able to see about twenty yards in front we began to hunt about for any signs of the tracks. We found nothing here, however, and moved through the jungle, keeping along a fairly fresh elephant track. On account of the great thickness of the jungle at this time of the year (June—July) we found from the tracks that most of the bison kept along the elephant paths and streams, and after a while we came to a spot which had been the halting place of the elephants—bamboos broken down, trees uprooted, and the place

a scene of wreckage. Here we found innumerable tracks of bison, all crossing and recrossing one another. From the signs of the tracks, which I could hardly distinguish one from the other, the Burman made me understand that there had been four or five bison there recently, one of which was a large one. It was clear from the tracks that they had entered this place by an elephant path on the right and had gone out again to the left. We decided to follow these up, to get, if possible, a shot at the large bull. These led us up and down very steep slopes which looked almost impossible for any animal to climb, and through the jungle which was getting comparatively open, the bamboo having given place to teak forest. After a time we were again in bamboo jungle, and there were unmistakable signs that the bison had only a short time ago passed this way. All the grass and young shoots had been bitten off, and the ends were still juicy, and had not yet turned brown. The grass, too, was all freshly trampled down. The going here was very slow, as we were all on the *qui vive* and expecting to come across the animal any moment. I and the tracker were in front, he carrying the spare rifle, while the two other Burmans followed a hundred yards in the rear. It was no easy matter to move over this ground without making a noise, as it was strewn with bamboos and dead leaves, every one of which we had carefully to avoid, and at the same time carry a heavy rifle at the ready, and keep one's eyes open for the bison in every direction. The slightest noise of a twig snapping, or a dead leaf being trodden on is sufficient to put the bison on the alert and start him off. We proceeded in this manner for a good two miles, the tracks remaining much the same all the way. The animal was feeding all along the trail, and there were signs that he had occasionally halted, so evidently he was not alarmed, and was unaware that he was being followed. As a rule bison lie down to rest about 9 A.M. in thick bamboo covert, remaining there till the afternoon, when they get up again and drink and graze. However, it was now past eleven, and he was still moving slowly. It was no doubt the myriads of flies, etc., which kept him on the move, or perhaps the cool, cloudy morning made him wander about a little longer than

usual. We were rapidly gaining on him, as the water he had just crossed was muddy, and the pools still had bubbles floating on the surface. A little way farther on he had had a roll in the mud, as from here on the leaves on both sides of the track were smeared with dripping mud.

Shortly our efforts were to be rewarded, for soon afterwards, on reaching the crest of a small rise, my tracker stood stock still and slowly pointed to a bamboo clump in a hollow about thirty or forty yards ahead. At first I could not see anything special, only a dark mass of jungle; but I kept my eyes glued to this spot for what seemed ages, holding my rifle at the ready. Then suddenly there was a noise of cracking bamboos, and the black mass moved. There was no doubt now that here at last was the animal. As he was clearly alarmed, and on the point of making off (having winded us), I gave him the right barrel of the 12-bore where I judged the shoulder to be. The cloud of smoke from the black powder hid everything for a few seconds, but as soon as it cleared I saw the bull lying apparently dead. The natives evidently thought the same, as there was much talking and mutual congratulation.

The two Burmans in rear having rushed up on hearing the shot we all proceeded towards the animal to examine him. What happened next must have been really amusing to anyone looking on, for when we were within about fifteen yards of the bull he jumped up, and with one snort came straight at me. As I had let down the hammer of the left barrel to half cock and had omitted to reload the right, it was only when he was about five yards from me that I was able to fire the remaining barrel at him. The only result of this shot was to cause him to change his direction from me towards the tracker, who was carrying my second rifle. He, however, jumped to one side just in time, throwing the rifle in the opposite direction to me as he fell flat on his face. He had tripped over a bamboo; but, luckily, the only damage he suffered was a slightly cut ankle, which the bison just caught with the tip of his horn as he rushed past. I could not help admiring the animal as he came on, with his nose almost touching the

ground, thus showing off his broad back and the great spread of his massive horns to perfection. He was now slowly staggering up the slope down which we had just come. Seizing the cordite rifle which the Burman had cast away, I got a steady shot at the shoulder which finished him.

On examining the animal we found that my first shot had hit him too far back, missing the heart and lungs, but the shock of the heavy bullet had knocked him down. The second shot (the one he got as he came for me) had entered his head at the base of his left horn (which it had shattered) and had gone out again at the side of the horn, not touching the brain. He turned out to be a young bull, with fairly good horns. The natives were soon at work, cutting off the head and taking enough meat to last until the next day, when he would be cut up and brought back to camp.

It was now well after midday, and I had settled down for a rest while the cutting up of the flesh was going on, and was enjoying a smoke, when from afar I heard a peculiar call, something like a high-pitched moan; this was repeated two or three times. Immediately there was tremendous excitement amongst the natives, and I then knew that it was the noise one bison makes in calling to another that I had just heard. The tracker came up, and, having loaded both rifles, we started off, and soon came on the fresh tracks of a large bison, going in the same direction as we were, and also tracks of a smaller one, coming towards where we had just been resting. We followed up the tracks of the larger animal, and had hardly gone half a mile when we saw the bison—a magnificent looking bull—standing by a clump of bamboos about 50 yards away. He was utterly unware that we were near and was contentedly eating the young sprouts. I only managed to get about ten yards nearer before he noticed something was up, for he suddenly turned round. I at once fired both barrels of the 12-bore at him, and immediately heard a tremendous crashing and stampeding on our left. We saw through the jungle that he was rushing on past us to our left, towards where the dead bull was lying.

The only thing to do now was to get on as quickly as possible so as to get a shot at him before he got too far away. There was little chance of our losing the direction, for we could always discover by the noise of the crashing of the jungle the line he was taking so long as we kept near. He was not going very fast now. I managed to get two shots at him as he went on, and down he went with a crash; but was up again in a moment, and coming in our direction.

It was almost impossible to get a really steady or sure shot on account of the thickness of the bamboos, which always partially hid the beast. We went on after him, as he had passed us on our right. I got a glimpse of him a little further on lying down; we were in very thick stuff now, and had great difficulty in getting along. I tried to get up to him (the wind was in my favour) and get a clear shot if possible. He heard us, and got up to go into jungle, which was getting thicker every minute. I had the cordite rifle in my hands and at last got a shot at his shoulder, which dropped him. I had learnt a lesson from the other bison, and so crept up prepared to give him another at close range to make sure. But on trying to reload found the magazine had jammed (the rifle was a single-barrel ·450 cordite, the other a 12-bore, firing a 580 grain bullet and 6 drams of powder). The black powder 12-bore was near, and I proceeded to open this, only to find that the card board cases were fast stuck, having got damp while in my pocket. The jungle where we now were was dripping with moisture, and our clothes were soaked through.

Here we were now in a nice fix—a splendid bull bison lying down not twenty yards from us, and apparently full of life, and we without any means of getting him! He was also making the most extraordinary noises. By lying down flat I could see that he had his head towards us; he could probably only see our feet. I did not feel very comfortable, as I expected him to come on every minute, for I was beginning to believe that lead had no effect on him. However, by cutting bamboos and ramming them down the muzzles, and hammering these with "dahs" we at last forced the cartridge cases out. To load I had to strip a good deal of the

outer covering of the cases before they would go into the breach. Then, after what seemed hours, all was ready.

As the animal was facing us I had to get round to a flank to obtain a side shot. He heard me, and tried to struggle to his feet and turned his head in my direction. A shot at close range finished him, and over he rolled on his side, a magnificent beast, and full of fight to the very last. I could not repress a passing feeling of remorse for the animal as he lay there. He had a very good head, his horns measuring 35in. across the sweep (outside to outside) and 18in. circumference at base, and the tip-to-tip measurement (round the outer edge and across the forehead) was 68½in. The amount of lead this bull took shows the great endurance and vitality the gaur has. Here was an animal that had received five fairly well-placed heavy bullets, and yet had to be finished off at close range.

Two days previously E. V. W. bagged a bison, which, after having a soft-nosed bullet from a ·500 high-velocity cordite through his lungs (the bullet was cut out under the ribs on the further side), charged full gallop up the steep side of a nullah, a distance of 47 yards, before he fell.

On talking over the day's work in the evening, the fact of getting the two bison was discussed, and the explanation very simple. This large one, which I had heard calling and had shot last, was the big one whose tracks we had been following all the morning. He had evidently met the smaller one at the place where we came on the bull which was shot first, but on our approach the elder one made off, leaving the younger to face us. The call which led us to him he no doubt made either to call the young one up or else to find out if all was well. As it was now late in the day we cut off the head and hung it up in a tree out of harm's way until it should be brought into camp next day. The successful day's work made the long trek back to camp seem much shorter than it really was. We moved from this district next day, as we had shot four bison between us from this place, E. V. W. having got two fine bulls a few days before.

The day here described, besides affording great pleasure because of its successful ending, also taught me by experience

several very important lessons. The chief of these were : (1) never to presume that because an animal falls down after being hit that he is dead ; (2) always in future to use brass cartridge cases and not cardboard ones when in thick jungle or during the rains ; (3) not to trust to a single-barrel magazine rifle, but to use a double-barrel one ; (4) to reload immediately after firing even if only one barrel has been discharged (that is, of course, if circumstances admit of it). *I shall certainly use an 8-bore the next time that I am lucky* enough to get a chance of going after the noble *Bos gaurus.*

While on the subject of rifles for bison, I quote Sanderson's remarks on the matter from his book *Thirteen Years among the Wild Beasts of India* : He says : " Heavy rifles are absolutely necessary for good work on bison. I prefer No. 8, with 12 drams of powder. I have only lost one bison I ever hit with mine of this calibre. Many bison have been killed with a 12-bore and 4-drams ; but an immense proportion of those fired at with such rifles have been wounded and lost, many to die a lingering death. The vitality and endurance of wounded bison are at times quite startling. I used a 12-bore spherical ball rifle and 6 drams, with hard bullets, for some time ; but I lost many bison, and never succeeded in flooring them as can be done with an 8-bore, even when wounded with the latter I have known bison hold on for long distances and take many shots. When one or more in a herd are wounded, and the herd makes off, it is very difficult to follow the wounded animals if the herd scatters, unless there is a strong blood trail, which there seldom is with bison wounded with small bores, as their thick hide closes over the wound. With an 8-bore a decided effect is soon produced, and the wounded beast will probably be found lagging behind before he has gone far." This was written before the introduction of the modern high-velocity cordite rifles ; but his remarks are equally applicable nowadays, especially as regards the " blood trail." One point urged in favour of these high-velocity cordite rifles is their flatness of trajectory (useful for a long shot) ; but how often is big game shot at a range beyond fifty yards ? From thirty to fifteen yards would be nearer the average.—(*By Pyoung in the Field.*)

NATURE'S ALARMISTS.

You are crawling along, snake like, over the ground, trailing your rifle beside you. The objective is buffalo of whose presence you have unmistakable fresh signs. The going is slow, over soft, spongy ground. Water percolates through the turf filling the indentations you make. The utmost precaution is observed, as the slightest noise is sufficient to put the quarry on the alert. A couple of hundred yards ahead is a tall belt of *Cyperaceæ* reeds which is agitated, here and there, as if a giant body were moving through it. A faint rustle and splash comes through the air. A few scattered clumps of *Ixora* and *Hibiscus* offer you cover. You are sure of a shot and creep at a snail pace with heart throbbing wildly.

Swish! a lapwing, excubitor to wild bird and beast, rises a short distance away with a startled cry and raises the alarm. Tit-tit-tera! Tit-tit-tera! The warning cry rings through the air and an answering crash from the belt of reeds leaves you swearing aloud. Pity-to-do-it! Did-you-do-it! comes the taunting cry over the open, and you consign in your heart all bird creation, and the Lapwing family in particular, to the nether regions.

The Red-wattled Lapwing (*Lobivanellus indicus*) is one of the most well-known of waders in India. Haunting the borders of rice fields, marsh and meadow land, and the margins of tanks it is the bane of the bird shooter as well as the big game hunter. Extremely wary and suspicious, it has an aggravating way of finding out the sportsman stalking game and alarming slumbering nature. Day or night it is extremely watchful, ever ready to raise the alarm; and great is the annoyance caused to shikaris and sportsmen by this vigilant watcher. Encamped in the vicinity of tanks I have always listened to its sharp and rather amusing notes at night-fall as it flew over the bund to the tank border. And watching for game in the shelter of a clump of *Hibiscus* one evening I had one of these inquisitive birds finding me out and raising an alarm which, of course, led to the game giving the place a wide berth.

The cry of the Serpent Eagle and the call notes of the Koel ring through the air, interspersed with an outburst of lively notes

varied by a number of loud whistlings and calls. The *Bhimraj* or Racket-tailed Drongo and the large crested ally *Dissemurus malabaroides*, swarthy tyrants of wood and jungle, are exercising their varied talents in closely mocking the feathered denizens of the forest. Of the former bird Mr. Bourdillon writes: "I have often been amused to hear it imitate the cry of the Harrier-Eagle and see it make a sudden charge down on some smaller bird, either in sheer mischief, or to secure some insect which the latter has captured." It has its own warbling notes, however, which it utters when acting as alarmist in the woods. The Crested Drongo too bursts out with a startling suddenness and lively notes on being disturbed in its native haunts.

In Ceylon the natives in the North Central Province think nothing of eating monkeys, held with such veneration in India, and spend long hours in the forest to try and pot *Hanuman*. The Ceylonese Crested Drongo (*Dissemurus tophorhinus*), peculiar to the island, is of considerable help to the semi-nude villager armed with shot-gun of gas piping. The alarm notes of the bird ring out unexpectedly and is continued with voluble reiteration. The swarthy tyrant has discovered monkeys feeding, or on the move, and reviles them soundly. Sure enough it is a monkey, for the faint crash of branch and leaf is heard gladdening the heart of the expectant Cingalee. Curried monkey is looming and monkey face smacks his parched lips with pleasant anticipation.

The monkey, on the other hand, himself acts as an alarmist where the leopard is concerned. An incessant howling and chattering breaks through the stillness of the forest. A troop of monkeys, charged with electricity, is engaged in peculiar antics. Young and old take part. Uttering loud screams they suddenly commence a spasmodic series of springs, anon slipping down branch and wire and prying and peering into the ground beneath. At a given signal all is silence and suddenly the performance begins anew. In the semi-gloom of the forest shade is seen on the ground a compact yellow body with clearly defined spots, still and motionless save for the gently undulating tail. *Chita-bagh* is playing on the curiosity and credulity of the monkey and trying to draw him as

the green tree snake draws the little bird into its coils. And at times he is successful.

Chink, chink, chatter! A succession of strident cries, sharp and insistent, rings over the cocoanut grove. The cry is echoed by the dusty *Sat-bhai* in a jerky screech, peculiarly its own, while the hen, scratching among flower birds in the garden, sounds a note of warning and the chickens lie motionless and still. A shadow passes overhead and the "squirrel-killer" glides over the tree tops on silent wing, scouring with searching eye the world beneath for a stray pigeon, chicken, or any small mammal which it can make a meal of. The common Indian garden squirrel (*Sciurus palmarum*), impudent invader of your bungalow verandah, is an extremely sharp watcher while running along a cocoanut branch or prospecting in the mango tope. Spying from his lofty coign of vantage the distant approach of scavenger *Chila* or predatory *Besna*, he raises the alarm, putting the inhabitants of grove and garden on the alert. The squirrel also keeps a watchful eye on what is transpiring below. Interrupted in my reading one day by the persistent chirrup-chirrup of "stripes," I looked up from my long sleever in the bungalow verandah to find the abuse directed to a large rat-snake which was busy making a meal of termites at an ant hill. The little squirrel was dancing about in great excitement at the base of a mango tree and informing all and sundry of the presence of a doubtful character in the garden.

This alarmist attitude seems to be common to the squirrel tribe. I have often noted while out in the forest the large and long-tailed prototype *Scirius macrourus* raising an outcry at the movement of man or beast. Rounding a large buttressed *Sterculia* in the jungle one day one of these squirrels raised its peculiar grating cry in alarm, and a rib-faced deer, with a clatter and clash scuttled for life, a passing glimpse of the whitish underside of the frightened Muntjak being all I had. Tracing the startled cries of these forest squirrels I have often come across game, the presence of which had been proclaimed in such noisy fashion.—(*By Velox in the Indian Field.*)

MISCELLANEA.

PRODUCTION OF SYNTHETIC RUBBER.

[*The following article has been compiled by Dr. E. H. Hankin, M.A., D.Sc., Chemical Examiner and Bacteriologist, United Provinces and Central Provinces, Agra, the main facts being based on a contribution in* Zeitschrift für angewande Chemie *of April 15th,* 1910.]

The leading authority in the scientific world on the chemistry of India rubber is Professor Harries, of Kiel, whose discovery of the chemical constitution of India rubber some years ago attracted general attention. In an address recently given on the subject, Professor Harries expressed himself as follows on the subject of synthetic rubber. A year ago he received a sample of India rubber that was stated to have been prepared by Heinemann's patent. According to this method, a mixture of acetylene, ethylene and chloride of methyl was led through heated tubes. Isoprene is thereby produced, which, by polymerisation, produces India rubber. Harries attempted to make India rubber by this process, but failed. The sample that he had received was indeed India rubber, but resembled an old piece of Para rubber. Should it be possible to make rubber by Heinemann's patent, then, according to Professor Harries, some special conditions not disclosed in the patent must be necessary. That is to say, should any one else succeed in making rubber from the same substances, there would be no infringement of the patent. But Professor Harries is very sceptical as to whether India rubber can be made from the above substances. He has received a sample of true India rubber made by Dr. Hoffman at the Elberfeld colour works, but he gives no details of the nature of the process by which it was synthesised.

In January of this year Professor Harries himself took out a patent for the production of synthetic rubber. His method

consists in heating isoprene in a vacuum with glacial acetic acid to a temperature of 170°C. By this treatment the isoprene polymerises, producing India rubber. The conditions of the experiment must be exactly maintained, otherwise slimy and resinous substances are produced instead of rubber. This artificial India rubber has all the characters of the natural product, and could enter into competition with it if only it were possible to discover a cheaper method of preparation. From the chemical standpoint, the synthesis is simple. Two molecules of isoprene combine together to form one molecule of dimethylcyclooktadien. This latter substance is India rubber under the chemical name that expresses the constitution of its molecule.

Professor Harries makes no attempt to forecast the future of synthetic rubber. Will the synthesis already achieved remain merely a curiosity of the laboratory, or will it develop into a process of commercial importance? The history of the commercial production of a synthetic compound comprises three stages. The first stage is the discovery of the arrangement of the atoms in the molecule. In other words, its chemical constitution has to be cleared up. The next stage is the discovery of a method of building up the molecule by some method, which, though of scientific interest, may be too expensive to have any commercial importance.

During the last stage chemists are concerned in discovering cheaper methods of synthesis, until at last they reach a method capable of competing with the natural product. In the case of indigo this last stage took twenty-two years. It would be idle to speculate as to whether it will take more or less time in the case of India rubber. It is possible indeed that the problem will never be solved at all. But, in view of the magnitude of the prize to be won, there can be little doubt that both money and brains are now being freely spent on the subject by those great German chemical works whose appreciation of the money value of scientific research often gives them the power of controlling the course of industries in distant and less enlightened countries.—(*Indian Trade Journal.*)

GERMAN TURPENTINE SUBSTITUTES.

The manufacture of turpentine substitutes in Germany is proceeding with considerable activity and commercial success, this technically prepared turpentine being obtained by the distillation of heavy petroleum from Borneo. It has been stated, says the American Consul at Hamburg, that the ordinary light American petroleum is not available for this purpose, but it would seem as though the grades obtained in Texas and California and perhaps elsewhere, might yield results comparable to those obtained from Borneo oil. It is not surprising that a fairly satisfactory turpentine substitute should meet with ready sale, inasmuch as ordinary American turpentine is now quoted at about 85 marks per 100 kilos, while the substitute can be had for 32 marks and even less. The odour of the turpentine substitute is not at all like that of American turpentine, and it is doubtful whether it can be used for pharmaceutical purposes. On the other hand, it is being used in the paint trade in increasing quantities.

Turpentine substitute was brought out in England about five years ago in consequence of the efforts of a powerful British company controlling the Borneo oil deposits to find an outlet for their petroleum. German manufacturers promptly entered the business, and there is lively competition between various marks now offered for sale. Doctor Eibner, of the Royal Technical High School in Munich, in reporting the analysis of one of the well known substitutes, thus recapitulates the essential points in regard thereto :—
"The sample transmitted corresponds sufficiently with the requirements of the modern substitute for turpentine oil in regard to boiling point, specific weight, and flash. It secures the solubility of resin and products of resin, nearly coming up to American turpentine oil, so that the differences to manufacturers of varnishes are scarcely noticeable. The sample examined, as compared with American turpentine oil, provides the same solubility for varnish extracts produced from copals, amber, and resin and therefore is susceptible of replacing American turpentine oil in the manufacture of oil varnishes for industrial purposes. The substitute may be used for the purpose of diluting stocks of commercial oil

varnishes. By virtue of its chemical composition, it is not subject to transformation when stored in half-filled vessels, and therefore does not produce a cloudy varnish, such as results from the use of old turpentine oils. The effect of the sample examined is not disadvantageous as respects the quality of producing a smooth coating." —(*London Chamber of Commerce Journal.*)

THE FORESTRY SCHOOL AT CAMBRIDGE.

The Forestry Committee report that in June of last year the Reader (Mr. Henry) began a series of experimental sowings of the different kinds of elms, which have yielded interesting results, showing that what were supposed hitherto to be varieties of one species, of unknown origin, are in reality combinations of two species, in which the Mendelian ratios are observed. Incidentally these experiments have drawn attention to the astonishing vigour displayed by certain first-crosses in trees, all of which hitherto had arisen accidentally. An attempt is being made this year to produce artificially similar hybrids in the case of the more valuable kinds of trees; and for the first time almost the production of new breeds of forest trees is being tried.

A plot on the University Farm has been assigned by the Agricultural Department to the Reader for forestry experiments, and about 5,300 seedling trees, of known pedigrees, are now planted out.

A small plot of *Eucommia ulmoides* has been established near Norwich, on the advice of the Reader. This tree, which was discovered in the mountains of Central China by Mr. Henry, is perfectly hardy and fast in growth in this country. Its bark produces 5 per cent. of rubber, the quality of which, however, is still a matter of doubt, as only minute quantities have been tested. It is proposed ultimately to treat this tree as coppice.

In last year's report the Reader referred to the need of museum and laboratory accommodation for research and teaching in forestry. Although no public appeal has been made for the funds required for this purpose, generous donations have been already

either given or promised, including Mr. H. J. Elwes, F.R.S. £1,000; N. M. Rothschild & Co., £500; Lord Iveagh, £250; Sir Dorab Tata, Mr. M. P. Price, and Dr. Herbert Watney, £100 each; Lord Peckover Mr. M. R. Pryor Sir John Stirling Maxwell, Mrs. Price (for the library of the Forest School), and Mr. Cecil Hanbury, £50 each; the Skinners' Company, £26 5*s.*; and Lord Kesteven, £25. A site for a forestry building has been allocated on the Downing ground by the Sites Syndicate.—(*Timber Trades Journal.*)

Photo. by E. A. Smythies.

(i). The Bhowali Stream.

Photo.-Mechl. Dept., Thomason College, Roorkee. Photo. by F. E. Smythies.

(ii). The Bhowali Stream showing a typical pool.

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ANIMAL *VERSUS* VEGETABLE MANURES.

The extracts we publish in this issue under the title of "Hygienic Treatment of Fruit Trees" quite revolutionise our ideas on the question of manures for increasing the fertility of soils. The question is one of such supreme importance that it deserves the most thorough investigation, for if, as Mr. Morgan states, the ordinary animal manures are actually harmful and prevent the production of healthy plants, it is high time that the fact should be established.

The question gives us much food for thought. For many years past, especially since Dr. Voelcker's visit to India, it has been accepted that one of the highest ideals to be attained in this country is a plentiful supply of fuel in order that villagers may save for their fields the cowdung which is so often burnt as fuel. Now we have the converse side of the question thrust upon us by Mr. Morgan. He says that the grains of the United Kingdom owe their softness of texture to the food furnished to the plant which bore them. If this is so, it must follow that the system so common in India of burning cowdung and applying the ash to the

fields is really the best way of utilising the substance and in this case it thereby serves two purposes. The cultivators in India may in general be said to follow very closely to Mr. Morgan's ideal. They seldom put filth to their fields and they do not seem to hold, as Mr. Morgan says numerous agriculturists do, that as far as manure is concerned its effectiveness is proportionate to its unsavouriness. Thus it may be that the system of cultivation in vogue in India has really been a help towards maintaining the quality of the food-grains and that had the Western system of applying strong-smelling animal manures been in vogue everywhere, it is possible that the food-grains would have deteriorated by now and that plant diseases would be more rife than they are. One of the things that strikes the ordinary observer in India is the generally healthy state of the crops. Now we may ask—Is this because strong animal manures are not very commonly used and where they are used, is it noticeable that plant diseases are on the increase? It seems common sense that when we sow good clean seed in a bed saturated with the most evil-smelling filth we can imagine, that we do not give the resulting plant a chance of living a clean life and keeping diseases at bay. It has been proved in many cases, we believe, that plant diseases are often spread by infected manure. Under Mr. Morgan's system the ideal is to insure as far as possible hygienic conditions for plants; and this, he maintains, is as necessary for plants as for animals. Are not the most fertile soils in the world almost free from animal constituents? This may indeed be one of the principal reasons why so-called virgin soil is so fertile. Mr. Morgan seems to have established his theory as regards fruit trees, potatoes, etc., and we think that a thorough investigation into the subject as regards food crops in India is necessary. Rotten vegetable matter (humus) is, it is maintained, the natural fertilising agent for soils which fact we foresters are well aware of. It is also one of the reasons why allowing land to be fallow improves its fertility. Animal manures before being applied to the land should, Mr. Morgan maintains, all be burnt first. There should be little difficulty in carrying out experiments, and it seems probable that the West may have something to learn

from the East where the burning of cowdung may after all be found to be the reason why the soils in India retain their fertility in spite of centuries of cultivation and a reason why plant diseases are not so common as would be expected.

The practice of shifting cultivation in many parts and of *rab* cultivation in Bombay both go to prove that in the East the idea of vegetable manures is in existence, though the people may not generally understand that they are really thereby improving hygienic conditions for their crops. It is true that in these cases the fields are manured with the ashes of vegetable products, but this is because there is not time to allow the usually woody substances to rot. In addition to the hygienic point of view there is no doubt something in the fact that manures derived from vegetable sources have the chemicals in the form most suitable for absorption by plants, whereas in animal manures they are in too concentrated a form. We do not think of feeding herbivorous animals on animal food and so, why thrust an excess of animal manure on plants which require only the constituents *of vegetable growth?*

At any rate Mr. Morgan has brought forward a subject, the importance of which cannot be overestimated, and we hope that experts will quickly investigate the matter so that we may work on right and strive after true ideals.

SCIENTIFIC PAPERS.

HYGIENIC TREATMENT OF FRUIT TREES.*

An excess of nitrogen, especially in the form of nitrate of soda or of sulphate of ammonia, produces injurious effects in the fruit field. I am prepared for criticism when I make this statement. It will come as a surprise to those who have been induced

* Extracts from an article, entitled "Fruit for Food and Food for Fruit," by S. Morgan in the *Fortnightly Review* for June 1910.

to use these materials through the laudatory commendations which have been showered upon them by chemists of repute. But I base my commendations upon careful tests. Both materials referred to destroy the natural flavour of fruits, produce insipidity in wheat, and, in the case of tomatoes, etc., are responsible for tons of nauseous specimens which are disposed of to the public each year. The use of manure is equally bad, and as to sewage, chemically treated or otherwise, its utilization for the production of fruits or plants for food should be prohibited by law. As far as manure is concerned, the notion prevails among numerous agriculturalists that its effectiveness is proportionate to its unsavouriness. Against this indefensible view I have pleaded for the hygienic treatment of all crops for years. The carbonate of ammonia present in the liquid manure from the stable is injurious to the roots of fruiting plants and trees. All thrive best under sweet conditions and clean culture, whether they are grown under glass or in the open air. That is why I have commended the annual washing of fruit trees with a clean, simple, home-made wash each season. Strong-smelling composts should never be permitted to enter the fruit farm or flower gardens of the patron of hygiene. If I am asked whether these composts are not essential, I reply they are not. Nay, more, I hope to show that far larger yields and finer fruits and flowers can be produced without them. Naturally, what I commend for fruits are equally suitable for grains, and general market garden products. Under the improved system of culture, manure or artificial fertilisers are unnecessary. I am not in sympathy with the chemists who are ever singing the praises of man-fed nitrogen. They may or may not get unlimited supplies of nitrates from the air. Most of what is needed by fruiting plants and grains is within reach, or under the feet of the cultivator, in abundance. He has simply to unlock the stocks which nature holds so tenaciously in her grip to furnish his trees with all the nitrogen they need. But, it may be asked, what are we to do with the millions of tons of manure which are produced each year? Practically that is outside the province of my propaganda, nevertheless, as it must be dealt with by some

agriculturists, I simply advise them to burn it. In response to this it will be said, but in doing so all the water and organic material in it will be destroyed. My reply is they will be, but that the residue left from the burning will, in my opinion, be found far more valuable than the nauseous compost. At first sight the importance of manure as humus-maker might appear to be worth consideration, but, for the sake of brevity, I simply say that I prefer the residue that has been purified by fire to the fresh material. I have noticed for years that the continued use of manure has been attended with the most unpleasant results. Never were aphides so abundant as they have been under its increased use. To such a pass have things come that there is hardly a garden in the four kingdoms where these obnoxious pests do not abound by the excessive use of nitrogenous material. It is utterly impossible to grow manure or sewage-fed roses without bringing about their infestation with the repulsive pests referred to. But I prepared to go further and spring a surprise upon the fruit-growers by maintaining that big bud, the black currant gall mite—*Phytoptus ribis*—owes its existence to those congenial conditions which are perpetuated by the free and continued use of manure. The pest has almost rendered the cultivation of black currants impossible in England. It has caused the loss of hundreds of thousands of pounds to fruit-producers. So far all attempts to account for the appearance and eradication of this pest have failed. In her time the late Miss Eleanor Ormerod, the great entomologist, with whom I often corresponded upon these and kindred matters, was unable to advise a remedy. If black currants are fed in the early stages after propagation with the natural plant-food, I commend in the present contribution, using a free supply of powdered stones about the roots, they will, provided no manure is permitted to come into contact with them, fruit freely in due course and resist the mite. Bushes propagated in this way, if fed with the natural plant-food alone year after year, will continue free from affection. The relations between stable manure, sewage, etc., and mildews, smuts, basal rot in bulbs, big bud, sucking pests, etc., are undoubted.

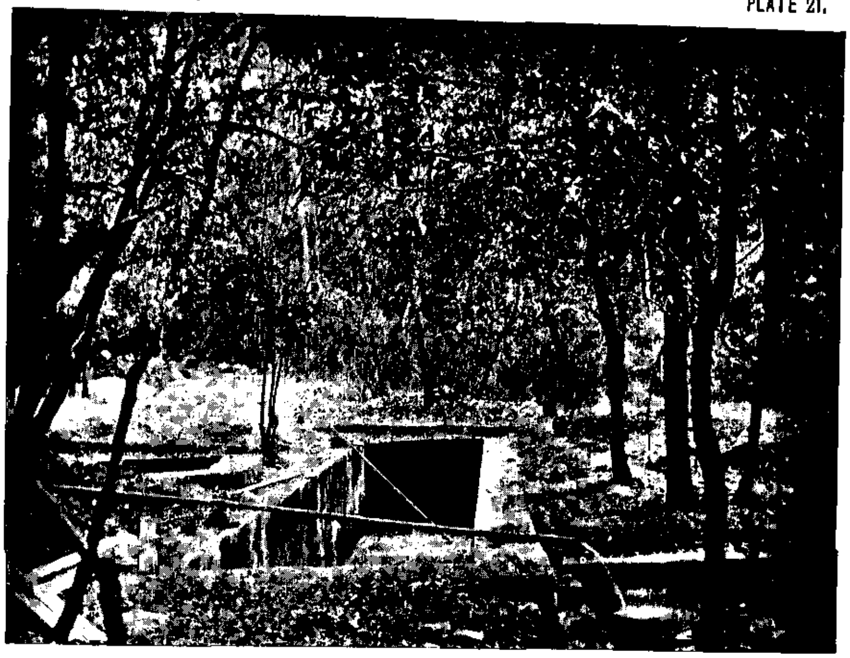
PLANT-FOODS AND HEALTH.

During the past season I had some pretty-looking tomatoes sent me for inspection. Upon being tasted, they were found to possess a disgusting flavour. To what was it due? I made it my business to enquire thoroughly into the matter, and in due course found that the fruit had been fed freely with sulphate of ammonia. The use of improper, or so-called plant-foods, undoubtedly affects the quality of the flesh of fruits that have been matured. In addition, they also injuriously affect the health and fruiting capacity of the parent plant. Many years' study in this connection has established these facts beyond doubt. If these materials affect the fruits they are fed to, can it be doubted that in turn the fruits when eaten affect the consumer? This being so, the subject becomes of considerable importance to the public and to those who are interested in the health of people. Vegetables fed with sewage, when cooking give off a pronounced unsavoury odour. Rose bushes fed with sewage or dosed with manure, particularly such as is saturated with ammonia from the stable, develop weak, watery growth, which readily falls a prey to sucking plant pests and degeneration of issue. It is sacrilege to feed the queen of flowers with sewage or manure. Anything which produces ammoniacal decomposition should be avoided by cultivators. Blindness in strawberry plants, and many other affections often result from the use of such materials. The hard-grained wheat which the importers prize above those produced by the home farmer, owe their firmness to a sweet and naturally fertilised soil. The grains from the manure-fed fields of the United Kingdom owe their softness of texture to the food furnished to the plant which bore them. Stable manure is responsible for the creation and perpetuation of many ailments. It affects the food-stuffs used for feeding cattle and men. I am satisfied that most of the dental troubles which afflict the community could be traced to the continued use of soft-textured manure and fertiliser-fed wheat. With the aid of the natural plant-food I have raised potatoes at the rate of over thirty tons per acre. This is five times larger than the general average yield according to the official returns of Great

Britain. But this is not all. The tubers produced were remarkably fine and large, clean-skinned, free from blemish or disease, and not a single potato from the test plot showed the slightest sign of skin-rust or scab. Now it is practically impossible to raise potatoes free from skin affection if the seeds are planted in contact with coarse, unsavoury stable manure. On the other hand, one can set the seeds if needed in the rotted vegetable refuse advised without the least fear of the potatoes grown being affected with the scab, although I prefer that the natural manure be placed an inch under where the seed potatoes are planted. Potatoes grown under this treatment when ready for harvesting have skins as clear as virgin gold, and thus their saleable value is increased considerably. During the twenty years and more devoted to the study of the question, I have never yet, with all the tests I have made, had a tuber which showed signs of scab or disease. The excessive use of nitrogenous material in the form of manure in potato culture is productive of weak growth of haulm, which lowers the constitution of the plants and tubers so that they readily succumb to the dreaded disease. With thorough drainage—I insist as to that, that all fruit and potato lands should be well under-drained—and the use of natural manure, sturdy, healthy development of the shaws will be ensured from the start. The after-growth will be perfectly hardy and capable of warding off disease. The importance of the new method of culture to the potato farmers and market gardeners is evident from the fact that the present potato-growing areas comprise over one million and a quarter acres. In the past millions of money have been lost through the potato disease. With the use of new seeds, and the planting of same in a well-drained soil enriched with natural manure, not only are disease and scab preventable, but the yield can be increased threefold, and the monetary value of the tubers harvested be enhanced considerably at the same time. Can any one imagine that the flesh of potatoes which suffer from the slightest taint of disease, or from scab of skin, a kind of eczema, really is as good for consumption as the flesh of tubers consisting of healthy tissues?

NATURAL PLANT-FOODS.

But nitrogen and humus are of vital importance in cultures generally, I shall be told. Of course they are, and the natural and proper way to provide them is as follows :—First, mineral matter can be furnished to the soil by the refuse obtained by burning manure, vegetable waste, hedge clippings, wood, and earth. Powdered stones dusted about the roots of rose bushes, for instance, will assure sturdy floriferous growth, and in season, a mass of exquisitely-tinted flowers unobtainable with the use of stable manure or with artificials. Powdered stones assure slow fruit-wood growth to bushes and trees and add to the flavour of the fruits in the most remarkable manner. For grain-growing they are of incontestable value. As far as humus is concerned, broccoli and cauliflowers, particularly, should be raised freely by the hygienic fruit-grower, whether he cultivates his trees for pleasure or profit, or both combined. The leaves of the plants should be fed to the soil, and when well rotted, will supply all the necessary humus and nitrogen needed. This decayed vegetable matter forms a natural, sweet and congenial plant-food for all crops with the burnt refuse referred to. It acts like magic upon fruit trees and grain-bearers, and forms the best compost for the florist that can be imagined. Apple-growers will find this method of feeding invaluable for the production of mammoth fruits. A supply of rotted cauliflower leaves placed under and within reach of the roots of trees will in due course assure the most luscious and toothsome specimens that one can wish for. Under this treatment hard-fleshed, coarse-grained apples are impossible. The trees fed as advised will yield an abundance of mellow, sugary, juicy fruits, which are the delight of the most fastidious consumers. Provided the heads of the trees are kept well open to the sunlight, the special kinds I commend are grown, and shallow surface soil stirrings are practised in the early part of the year as soon as the sun warms the soil and permits the operation being carried out, perfect fruits may be produced in abundance. Leaves of trees, piled one year at least, are more efficacious for all cultural purposes than manure. They form a valuable compost and contain plant-food in a suitable form. In these matters things must not be judged by the dictum of the



One of the big tanks, 50′ × 8′ × 8′.

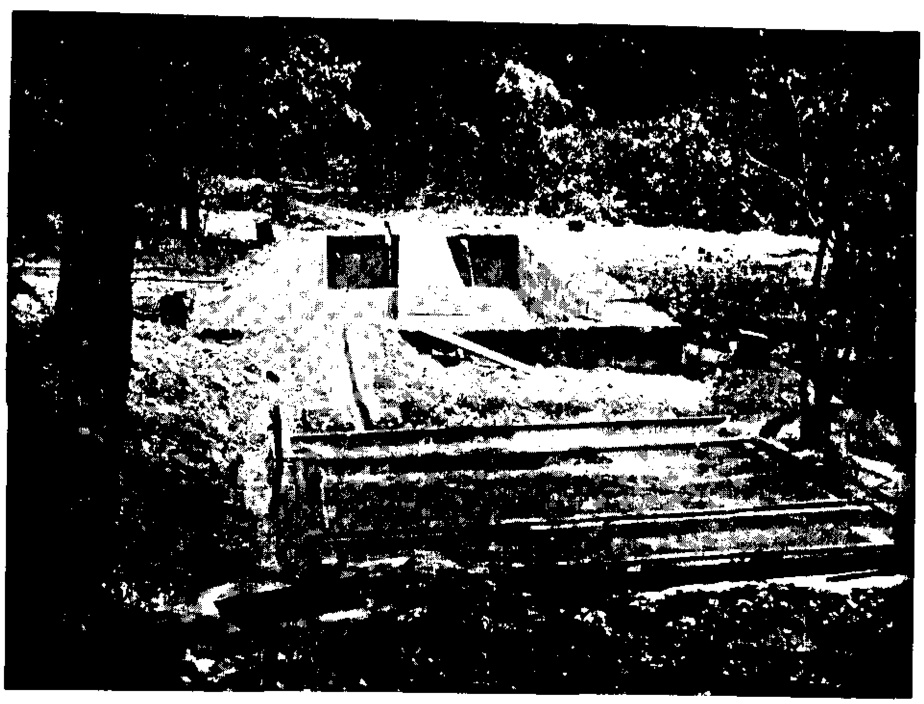


Photo.-Mechl. Dept., Thomason College, Roorkee. Photos. by E. A. Smythies.

The Hatchery—two tanks just made and being filled with water. Smaller pond in foreground containing 3,000 to 4,000 young fry.

THE INTRODUCTION OF TROUT INTO KUMAUN.

chemist, but by the result of experience. Experience is the best guide. With the aid of leaves treated as stated, splendid crops of fruit and grains can be raised without risk. Test the system with two apple trees and mark the results. The fruit from the one fed in accordance with the teachings of nature will be found to be larger and finer in appearance and colour, whilst the mellowness of the fruit will astonish the experimenter. The sarcocarp of apples fed as commended will respond readily to the treatment, and once again prove that practice is better than precept. The importance of the system I outline is best evidenced in the ready way in which it furnishes the soil with rich humus, and with this the texture of all fruits can be improved and their size be increased in the most striking manner. As to strawberries, they will, under its influence, swell out to twice and thrice their average proportions. With the aid of rich non-stimulating humus obtained from decayed leaves, the fruit-grower can literally blow out his fruits like air-bubbles. Through humus the soil acquires porosity, and this, in hot spells, assures moisture to the roots of trees growing in it. Decayed turf from grass or clover lands is, of course, of great value, but I have confined my advice chiefly to leaves of cauliflowers, especially as the latter form a profitable crop and the plants yield an abundance of foliage. At the same time I insist upon the necessity of piling the leaves till they are well rotted, and of applying them preferably in autumn and winter months. As it has been said, "a soil rich in humus is rich in nitrogen," the importance of rotted leaves of the nature of those referred to is evident. I consider, in brief, that this paragraph contains the secret of all fertility.

ORIGINAL ARTICLES.

THE INTRODUCTION OF ENGLISH BROWN TROUT (*SALMO FARIO*) INTO KUMAON.

It was many years ago that the Mahseer were introduced by Sir Henry Ramsay into the numerous lakes which lie roundabout Naini Tal in the Kumaon Division of the United Provinces. In

these they have thrived and grown apace, and although in some of the lakes a fair basket of fish may still be caught, in others, and in the Naini Tal lake especially, the monsters of the deep scorn the cunningest imitations of their own too plentiful food. This state of affairs led to various gentlemen in Naini Tal discussing the possibility of removing these useless fish and introducing trout, but nothing came of it, and the origin of the present experiment is due to the initiative of the Hon'ble Sir John Hewitt, K.C.S.I., C.I.E., the Lieutenant-Governor, who (for other reasons than the somewhat parochial one of bringing a more sporting fish to Naini) was anxious to try and introduce trout into Kumaon generally.

He asked Colonel Ward (who had started the introduction of trout in Kashmir) to advise on the likelihood of success, and the suitability of the various lakes and streams in Kumaon.

At Colonel Ward's suggestion, Mr. Mitchell, the present Director of Fisheries, Kashmir, was asked to come and make a tour, and help with his expert advise, and he arrived at the end of October 1909. It was shortly before his arrival that a suggestion, that the experiment should be put under the Forest Department, was sanctioned by His Honour the Lieutenant-Governor. The following extract from a letter of Mr. Clutterbuck's shows the aim and general outlines of the scheme :—

> "About the proposed introduction of trout, I have been talking to Colonel Ward, and he agrees with me that the first thing to do is to establish a hatchery. We should have to construct a series of tanks and ponds, and extend them as the fish grow bigger. Our aim should be to produce our own ova as soon as possible. As soon as we have reached that stage, we shall be in a position to try the stocking of various rivers and lakes, and in the meanwhile we can consider which will be the best for the purpose. Colonel Ward thinks that the whole arrangement should be managed by the Forest Department, and I agree.
>
> When we have paid for the construction of the hatchery and tanks, the expenditure will become very small, and will be confined to establishment for watching the hatchery, the

cost of feeding the fish, and the cost of transporting them to the rivers, where they will be liberated.

Colonel Ward has kindly promised to give his advice at all times, if the Forest Department undertake the management, and his expert advice will of course be essential."

To return to Mr. Mitchell. He made a tour through Naini Tal and Almora Districts, but lack of time prevented him from reaching the upper waters of the main rivers; some difficulty was also experienced in finding a satisfactory site for a hatchery, the requisites for which are—

(1) sufficient extent of flat ground,

(2) continuous supply of water,

(3) cool and shady position,

(4) easily accessible to Naini Tal, to allow of frequent inspection.

Three or four areas were considered, but at length a thoroughly satisfactory site was found * about two miles from Bhowali, and 8 miles from Naini Tal, which was inspected and approved of by Mr. Clutterbuck at the end of December.

The site for the hatchery having been selected, the next thing was to prepare ponds, tanks, etc., for the fish. Mr. Mitchell kindly sent the plan of the Kashmir hatchery as a guide, but the conditions of the ground at our disposal prevented the plan from being followed to any extent. A site plan of the hatchery as it has gradually evolved up to the present is given in plate 22, and a description of it may not be out of place.

The site selected for the hatchery is on a small piece of flat ground about 100 yards long by 20 broad, in a narrow valley with steep, almost precipitous, sides rising up over 2,000 feet on each side. The elevation of the hatchery itself is 5,200 feet, and it is beautifully shaded with oaks, etc., and always cool. The water-supply is never-failing and sufficiently cool, the maximum temperature obtained in the beginning of June being 63° F.

The ground is mere *débris* brought down by the little stream, composed of gravel and boulders, and every portion of the work

* By Mr. Smythies.—HON. ED.

had therefore to be made thoroughly solid and water-tight. The intake of water is some little way above the hatchery, and protected by two strong walls, as the stream is apt to be very turbulent in the rains. A little tunnel in the wall lets the water into a channel 30 feet long, from which 2 pipes of 2-in. diameter lead the water 370 feet to a settling tank. From here a masonry channel, with a smooth cemented surface, leads the water past the hatching shed to the system of tanks and ponds. In years to come, when we are obtaining our own ova, a pipe will be taken off to the hatching shed, so that water may trickle down through the hatching boxes. The hatching shed itself is a well built masonry building without doors or windows, but the eastern side is left open.

The system of tanks and ponds needs little explanation, as the accompanying plan and photographs make matters plain.

In one of the photographs, plate 21, may be seen 2 medium-sized tanks (35′ × 4′ × 4′) just completed, and being filled with water. In the foreground may also be seen a small pond (10′ × 10′ × 2′) with the protective wire-netting. This wire-netting was put over the shallower ponds, in case kingfishers, frogs, or other vermin should try and prey on the young fry, while for the big tanks no protective covering was thought necessary. Up to the present unwelcome visitors have not yet found this secluded retreat.

The tank marked X on the plan has still to be constructed. It may be added that every part of the work has been very thoroughly constructed, the tanks, etc., being formed of lime masonry, concrete flooring, and several coatings of cement. All the outlets are of course carefully closed with fine mesh gratings, so the trout have small chance of escape.

The work of construction was started on 1st January 1910, and finished about the end of May. Next year one or two more medium-sized tanks will have to be constructed, to accommodate the growing fish, but the chief works of construction have now been completed. The total cost of these works has been about Rs. 3,300.

To return to the beginning. By the advice of Mr. Mitchell, 30,000 ova were asked for, from Kashmir, and by the munificence

of His Highness the Maharajah of Kashmir, these were supplied free of cost. For this act of generosity our best thanks are due to him.

The ova left Srinagar on 15th January, and after being snowed up for two days arrived in Bhowali on 24th in splendid condition, only 300 eggs (out of 30,000) having gone bad on the way.

For those unacquainted with long-distance despatches of ova, a short description of the method of packing, etc., may be of interest.

"The ova are placed in trays 12"--15" square and about 2" deep, with perforated zinc sheeting for the bottom. The ova are spread out uniformly on the bottom and covered with a layer of moss, and powdered and crushed snow or ice. This ice as it melts, is renewed from time to time, so that the ova are kept at a uniform temperature of 32° F. The perforated zinc allows the melting water to trickle through.

From 10 to 12 of such trays are put on top of one another, and placed in a felt-lined wooden box, so as to fit tightly, and all cracks and crannies are stuffed with moss and ice. The felt both reduces the jarring to a minimum, and acts as a non-conductor. To show what excellent results this can give in careful hands, it is only necessary to quote the example of the ova received from Kashmir, out of which, after about 200 miles by tonga, 650 miles by rail, and 28 miles by local bullock-cart (a journey spread over nine days), over 99 per cent were in beautiful condition on arrival.

The ova, as soon as they arrived, were put into hatching boxes. These are wooden boxes 6' × 1' × 6", in which a series of perforated square zinc trays (1' × 1' × 3") can be fixed, and the water which flows into the top of the box, runs through the series of trays. Into each tray is put 2,000 to 3,000 ova, so that each hatching box holds 10,000 to 15,000 ova.

As it had been impossible in three weeks to get anything ready at the hatchery, the ova were left in the hatching boxes, and these were put in the stream near by, the temperature of which was 47—52° F.

On the 3rd February, that is, within a week of arrival, the young alevins began to hatch out, and by the 15th the hatching process was completed.

During the hatching-out process, ova were from day to day picked out as they went bad, and dead alevins had also to be picked out. Some of the young trout which hatched out, had two heads, or two tails, but all these freaks died within two or three days.

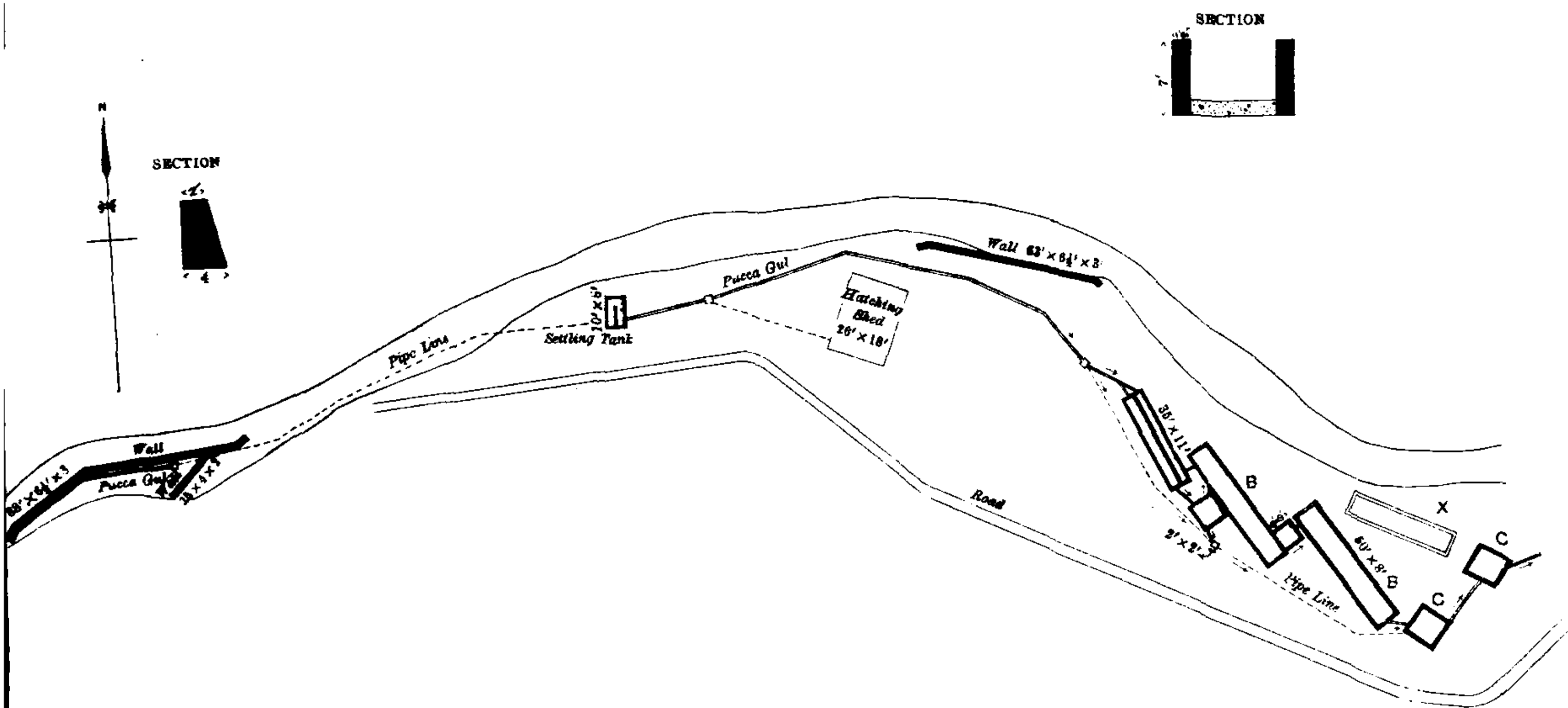
Unfortunately no careful record was kept of the number which were lost during this time, but 5,000 would probably be about the mark. At the same time a direct experiment was made of putting 2,000 in the stream at Bhowali. These hatched out in a separate "Pahari" box and soon after hatching out, *i.e.*, as alevins, were put direct into the stream. This was of course wrong, as the feeble little fish should have been kept out of harm's way until they could swim and balance themselves against the current. Two months afterwards, with much searching only two or three survivors could be found. Probably one per cent of the survivors were not seen, however, as small trout have a miraculous power of hiding themselves.

In case the idea of young fish being unable to swim may seem strange, it may be interesting to trace shortly the evolution of young trout from the egg.

The healthy ova are of the size, shape, and consistency of large sago, but the colour is pink. Inside the ova two small black spots and a thin black line (the eyes and backbone of the embryo) may be seen. Unhealthy ova look hard-boiled and opaque.

As the embryo develops, the spots and line become more conspicuous, and the actual hatching-out process consists in the head and, after great struggles, the tail becoming detached, while the remainder of the egg remains attached to the middle of the fish, forming a sac. In this stage the young fish is called an "alevin," and appears topheavy, lop-sided, and very feeble, and quite unable to struggle or swim against a stream.

In its natural state the young alevin remains hidden away amongst the stones and pebbles of the gravelly bank where the ova



SITE PLAN OF TROUT HATCHERY AT BHOWALI

Scale—1 Inch = 64 Feet

Mechl. and Litho. Dept., Thomason College, Roorkee. Zinco., August, 1910.—No. 6866 325

were originally laid, and lives for about three weeks on the contents of its sac, which becomes gradually absorbed. After this stage the "alevin" becomes a "fry," of active and inquisitive habits, and never sated appetite, and the little fish comes out of retirement from amongst the pebbles, and swims about on the shallows finding its own living.

To return, however from this digression, to the 23,000 healthy alevins left in the hatching boxes to look after themselves.

By the end of February, the majority had lost their sacs, and started to look for, and take food, and as by then the two lowest fry-ponds were ready, they were transferred to them, and as the remaining alevins became fry, they were transferred also.

Feeding was started at the same time. Finely minced up liver, ground through a small-pored grating, being their somewhat monotonous diet. The young fry throve and grew amazingly, and by the end of March a seer of food was being given daily. But this proved quite insufficient for their requirements, and they began to die with alarming rapidity, as is shown by the following table :—

6th April 1910 ...	3	12th April 1910 ...	212
7th " ...	10	13th " ...	311
8th " ...	51	14th " ...	320
9th " ..	70	15th " ...	430
10th " ...	50	16th " ...	310
11th " ...	99	17th " ...	340

At this critical stage of affairs, Colonel Ward luckily arrived in Naini Tal, and very kindly came out to the hatchery to advise. He diagnosed the case immediately as starvation, and the supply of food being doubled, the death-rate dropped at once.

Variety was given to their diet also by giving a seer of pounded and grated fish a day and, later on, varying quantities of white-ants.

The two-fry ponds (marked B on plan) and two large tanks (marked C) were ready by the end of April, and the young fry were distributed about between them.

By the middle of May there were still 18,000 or 19,000 fry (number estimated) in the various ponds, and it was thought it would be a good thing to dispose of some of them. Accordingly about 300 were turned into the Bhowali stream near the hatchery, and they have to the present been thriving splendidly.

Also two consignments containing 1,800 to 2,000 fry each were taken up to Naini Tal lake at night, of which 42 perished on the way. A week later the young trout could be plainly seen darting about in the weeds and on the shallows, and were evidently finding sufficiency of food and were looking after themselves satisfactorily. A month later, however, a careful search disclosed only a few fry in the shallows round the edge of the lake. These had not grown to any great extent, and probably the majority had retired into the weedy and deeper parts a little further out, and were thus invisible from the shore.

It is apparently characteristic of trout, however, when put into a lake, to disappear for a year or two, and at the end of that time, if they have succeeded, to appear as merry young ½-pounders, or larger, according to the supply of food available.

If it is true (which I doubt) that the lake fish have only existed, but not progressed, a great deal more can be said of the stream fish at Bhowali. From time to time a few trout have occasionally been taken out of the tank and put into likely places and pools in the adjoining stream, (which by the way is an ideal trout burn, *vide* plate 20,) so that in all about 400 have probably been added since the first consignment of 2,000 alevins was let loose. There is no need here for shrimp and minnow farms or crab and beetle cultures—the whole water seems alive with every sort of food—and the pampered youngsters are showing their appreciation of the state of things by growing at a fabulous rate. They have already occupied all the best places in the stream, and seem to be employed all day in eating the minnows which they can, and chasing those which they can't.

Two or three were noticed at least 6 inches long, while they have still to achieve their 5th monthly birthday. To return, however, to the 14,000 left in the ponds, by the end of May these

were an average size of about two inches. In each pond, however, were two or three monsters of 4 to 5 inches which, it is feared, had taken to a frateriverous diet, and after much trouble these were caught and put separately. The food-supply have been gradually increased, and now (*i.e.*, July) 4 seers of fish and liver are given daily.

I think we are justified in saying that up to the present the experiment has been an unqualified success.

If matters continue as they have been doing at present, it is expected that 10,000 fry will be in the tanks and ponds of the hatchery by the autumn.

It is impossible to keep this number there, and opportunity will be taken to stock the various lakes and streams around Naini Tal with trout.

It is hoped that six or seven thousand fish will be disposed of in Naini Tal, Sath Tal, possibly Bhim Tal, and several small streams in the vicinity. The balance will be kept in the tanks, and fed up, and in the autumn of 1911 the first supply of ova will probably be obtained, provided the temperature falls low enough. From then onwards a continual and increasing supply of ova will be obtained with which it will be possible not only to add more fry to the vicinity of Naini Tal, but also to send consignments of trout ova or fry to stock the various rivers of Kumaon and Jaunsar, or even further afield.

If any argument may be based on the start already made in the Bhowali streams, the trout put into tbe local small streams will grow with a rush at first, so that soon two or three pounders may be caught—and natural ova may be given in November or December of next year.

But to judge by the analogy of the famous Blagdon reservoir, and other places, the second generation will not find the glut of food which was available for their fathers, and there will be fewer giants in those days. It will be to the upper waters of the bigger rivers, to the Gumti and the East Ramganga, the Tons and the Pindar, that we shall have to look to supply the whoppers, wherever the temperature falls low enough. And whoppers they

will surely have to be, to strive successfully against the 30 and 40 lb. Mahseer of some of those rivers.

However, we have wandered from the region of prosaic fact into a rosy-tinted future, and ten years hence we may know more of these matters.

E. A. SMYTHIES, A.C.F.,
Naini Tal Division.

FOREST DIVISIONS.

Mr. F. A. Leete's interesting notes on forest divisions in Burma and the United Provinces lead one to hope that more officers in charge of divisions will favour readers of the *Indian Forester* with a short account of their respective charges.

While agreeing generally with Mr. Leete's remarks, there are a few points on which my experience causes me to differ.

In my division (Surat) all temporary quarters have either been replaced, or are about to be replaced, by permanent buildings. But I do not approve of the P. W. D. types, which comprise houses with unnecessarily thick walls and a minimum of convenience inside; I refer to pegs, shelves and other comforts. As teak is plentiful and allowed free for Forest Department buildings, we have made this timber, resting on masonry pillars, support our roofs, and then built the outer walls the thickness of the length of one brick, the inner partitions being the thickness of the width of a brick only. There are rest-houses 25 years' old, the upright posts of which, stuck into the ground even and not resting on pillars, are still perfectly sound, and there is a teak post in Surat on a verandah of one of the old "John Co." houses sound though, resting on the earth for over a hundred years. This reduction in thickness of the walls which does not make the buildings any the less serviceable, so reduces the cost that a good three-roomed rest-house, two-roomed rest-house, and five-roomed servants' quarters can be built on an average within Rs. 2,500, Rs. 1,500 and Rs. 600, respectively. Two rest-houses with plank walls have been tried, but are not a success; they are no cheaper than houses with

masonry walls, and are hotter by day and cooler at night, *i.e.*, one is roasted in the hot weather by day, frozen in the cold at night.

Para. 17 of Mr. Leete's article is a good argument for not wasting money on enormously thick walls.

My experience is that the Forest Department can build either a road, ordinary house or well far cheaper, and for its purpose quite as serviceable as the P. W. D. It is only fair to state, however, that we take the teak free and show expenditure only on cutting, etc. But the P. W. D. spend far more, especially on materials, partly because their work is often in a civilized place where rates are high, partly because they give building contracts and the middleman has his profits to make, and partly because the Executive Engineer is often given too little notice of intended expenditure.

In Surat we found that a contract for a building only paid in the more civilized places where, as a rule, the amount of construction was small, rates were high, and it was not possible to manufacture materials in the forest.

In the wilds the contractor and his men, besides being unaccustomed to the country, got fever and scamped their work, or broke down altogether and caused a year's delay in construction. It sounds absurd that operations should be cheaper in the more inacessible forests, but it was so, for there we had our own potters, etc., employed generally for the whole season, year after year, and bricks were turned out, often close to the building site, at Rs. 5 per 1,000, pot tiles at Rs. 4. A sufficient number of artisans became acclimatized or came in from other unhealthy places. Lime, though manufactured cheaply and well, had often to be carried a long way on bullocks from some deep valley or from a neighbouring district, but even so we never touched P. W. D. rates. The chief trouble was when bricks and tiles could not be turned out near the site and especially when water was scarce.

For the D. F. O's house in Surat Rs. 18,000 have been provisionally sanctioned ; if the F. D. help in supplying material, the estimate, allowing wood free, can be reduced to Rs. 15,000 or Rs. 16,000.

Where an edifice is at all of complicated design, the P. W. D's superior technical knowledge is a great help, of which I have always made use, and it is probable that the D. F. O., Surat, and P. W. D. will work together when the D. F. O's house and the Ahwa Distillery, far more difficult than an ordinary rest-house, are taken in hand. It is as well to mention that in Surat Division there was a definite scheme of buildings, that all arrangements were made well ahead, while the artizans moved from place to place and wasted no time.

As regards roads, the P. W. D. made an excellent metalled road, one mile long over Jakharebari in the Dangs, the total cost being over Rs. 36,000. A little further south the F. D. made a serviceable fair-weather road, two miles long, well within Rs. 10,000, and this road could easily be completed as a metalled road for another Rs. 10,000. The ground was equally difficult in both cases.

Mr. Leete discusses roads from a forest administrative point of view. In my opinion the construction of roads in the Dangs, where above 200 miles of rough cart tracks have been completed, is justified for the benefit of the local inhabitants, leaving the F. D. entirely out of the question, though each road in this case means an increase of forest revenue also.

The same argument applies to wells, of which a large number have been commenced or completed.

As regards firelines, there seems a concensus of opinion in favour of cleared lines in spite of certain drawbacks. I have, however, noticed one case in which they appeared a mistake, *i.e.*, a forest with (for a forest) very rich, moist soil where the original growth of grass was, on the removal of the trees, replaced by a fearfully dense growth of reeds; the latter would not burn standing, and the necessary cutting and beating down prior to burning has raised the cost of protection considerably.

Firelines that do not follow roads or footpaths have been dropped in the Surat Division, except along the outer boundaries. Consequently Mr. Leete would find the same cause for complaint as he does in Tharrawaddy. We look upon the prevention of the outbreak of fire as the primary function of a fireline, and the danger

of outbreaks inside the forest is chiefly along the frequented roads and paths. There are many other advantages, too, in having fire-lines, especially if cleared, coinciding with roads. This view was adopted at the conference on fire-protection held in Poona in July 1909, and in future fire tracing in the Bombay Presidency is likely to be restricted accordingly. Personally I have found other lines, especially along the boundaries of adjacent States, which must originally have been laid out by persons, who foresaw the advent of aeroplanes, extremely difficult to trace or inspect.

In Surat Division the remaining lines may now, I think, be looked upon as permanent, because they are required by the people to facilitate traffic as much as for protection. If there is any exception, it would be of the outer, and along other States and Divisions hideously difficult lines, which would cease to be needed as soon as our neighbours stop fires, a task they are now busily undertaking.

E. M. HODGSON.

NOTES ON THE YENADIES, A JUNGLE TRIBE INHABITING SRIHARIKOTA, IN THE NELLORE DISTRICT.

Sriharikota is an island situated in the south-east corner of the Gudur Taluk, of the Nellore district, between the Pulicat Lake and the Bäy of Bengal. This is connected with Madras, which is about 45 miles to the south, by the Buckingham Canal, the chief means of traffic. The ground is almost level and the soil is sandy. The annual rainfall is about 40 inches, the north-east monsoon contributing the most.

There being no irrigation sources, wet crops are practically nil. Dry crops, chiefly ragi, are raised by means of irrigation with pots. There is only very little *Casuarina* plantation owned by private individuals. The area thus brought under cultivation and under private plantation in this island is insignificantly small and the greater part of it supports a forest containing a moderately thick growth of species of trees yielding either good fuel or minor produce. It is peculiar that a natural forest of about 24,500 acres

should exist in a sandy tract. The chief trees found in the area are 1 Mushti *(Strychnos Nux Vomica)*, 2 Kunkudu *(Sapindus laurifolius)*, 3 Narudu *(Pterospermum lanceæfolium)*, 4 Chikreni *(Albizzia amara)*, 5 Neredu *(Eugenia Jambolana)*, and 6 Tamarind *(Tamarindus indica)*. The following shrubs are found as undergrowth: 1 Alli *(Memecylon capitellatum)*, 2 Gonji *(Glycosmis pentaphylla)*, 3 Kundaneredu, etc. In marshy places and by the side of Vagus are found, 1 Kadapu, 2 Nalla-maddi *(Terminalia tomentosa)*, 3 Kanuga *(Pongamia glabra)*. Pidatha is found abundantly in patches which is peculiar to this place. This shrub grows into bushes which serve as place of shelter for the Yenadies. This species does not appear to grow in other places in this district and in the neighbouring districts of Chingleput, North Arcot and Cuddapah.

This forest contains no good water sources except ponds excavated during the time of the Poliagars and the Vagus, which are rain-fed. The water in these Vagus is fresh during winter, but in summer it becomes brackish owing to their proximity to salt water.

Sriharikota is notorious for fever and elephantiasis. The former disease is the direct result of the mosquito bite combined with other causes, and the latter is due to drinking the water of ponds containing rotten growth round them.

It is in this forest that the tribe called Yenadies have lived from time immemorial and found ample provision in edible roots for their maintenance and the bushes therein afford them shelter. These Yenadies are generally very timid and they do not appear strong in physique. Almost all of them appear sickly, languid and lean. They are a set of dirty people having no inclination to bathe. They are not inclined to hard labour, being accustomed to lead an easy-going life, but they are quite a contented lot as shown by the fact that they are satisfied with the mere roots and leaves found in the forest. They are not fond of rice, but like conjee water much, which they get from the inhabitants in exchange for fuel. They generally do not drink the water in the ponds, but make a hole at the water's edge and then drink to

their hearts' content like animals, the water that percolates into it.

Their dialect is an admixture of Tamil and Telegu with a slang peculiar to themselves. Their method of hunting is a novel one. They do not kill birds with bows and arrows or any other destructive weapons. They first follow the footprints of animals or birds and after tracing them out, chase them and kill them by sticks, 10 or 20 persons combining for the purpose. In the case of birds, one man climbs up a tree and the others beat about the bushes. The bird being disturbed flies off and alights in another bush for hiding about 100 or 200 yards away. The man on the tree watches the direction the bird has flown and informs the others. They run after the bird in that direction and disturb it again. Thus the bird having flown two or three times becomes so exhausted as not to be able to fly again. The men then catch it. It is by this tiring method that the Yenadies catch wild fowl, partridges, etc.

This tribe is not afraid of snakes. They kill any kind of snake, even the most venomous, with the utmost ease. They are experts in administering medicines for snake-bite. The medicines are obtained from the plants and shrubs found in the forest.

The members of this tribe are excellent trackers and they can trace out any man by his footprints. What is more curious is that they can identify the footprints of cattle also, and can recognise footprints as being of a particular cow or bull belonging to a particular person of a certain village.

They as a tribe are lovers of music. After the day's labour is over, and after finishing the sorry meal prepared by their female members, they begin to sing to the accompaniment of a drum. In this music party males and females join together. One can hear such singing continued till late at night, sometimes even till midnight. Sometimes the singing is followed by a kind of dancing, which is peculiar to this race. This is not a regularly organized dance, but consists in moving the body from one side to the other, with knees bent and with hands awkwardly stretched out, and combined with extraordinary grimaces. It is a regular monkey dance, in which this tribe take a great delight.

THEIR CONNECTION WITH THE FOREST DEPARTMENT.

In early days, the Government took under its protection some Yenady families and employed them in the collection of minor produce. It is on record that from the year 1881 these Yenadies have been engaged on this work, and it is said that they were likewise employed even prior to that year. There were 75 families maintained by the Government. In the year 1887-88 a small village was laid out near Kasba under the name of Broughampet, after the name of the then District Forest Officer Mr. Brougham. The following minor produce is collected: 1 Nux Vomica, 2 Soap-nuts, 3 Tamarind, 4 Rattans, 5 Surati bark, 6 Honey and roots, such as 7 Sarsaparilla, 8 Iswara, 9 Vishabuddi, 10 Kukkapala, etc. Even to the present day, Yenadies alone are employed in the collection of the above produce and they are paid every day on the quantity they collect at fixed rates sanctioned by the department. In this collection work females are also employed. Each person earns about two annas daily. Sometimes outsiders such as Malas are employed in the collection of Nux Vomica, Soapnuts and Rattans, when the crop is abundant and beyond the collecting capacity of the Yenadies. It is gratifying to note that minor produce alone brings a revenue of more than Rs. 7,000.

THEIR CONNECTION WITH THE FELLINGS OF THE DEPARTMENT.

The fellings in previous years were under the pollard system, as the stools used to be left one foot above the ground. This system lasted long and it was changed into coppice with standards, when the area was brought under a working plan in the year 1899. Since then all trees are being cut flush with the ground after leaving some trees as standards. Generally, 1 Mushti, 2 Kunkudu, 3 Tamarind and 4 Margosa are left as standards, as also healthy and straight-growing trees, such as Neredu, Billu, Pidatha, etc.

Every year about 750 acres are cleared of trees to get an outturn of about 7,500 tons of fuel, which is exported to Madras for sale. The outturn of the forest is between 10 and 12 tons an acre. On this work about 200 coolies are employed. They work

under commission Gumashtas who are paid at 1 anna a ton for the supply of labour, in addition to the felling charges, which go to the coolies. Of these coolies about 100 are Yenadies, the rest being of other castes, *viz.*, Reddies and Malas. At first great difficulty was felt in getting the Yenadies to do this work. Gradually they got accustomed, so that they now go to work willingly. Females are also employed in this work as they help the male members in clearing undergrowth and in cutting small twigs, etc., of the felled trees, with small knives, leaving to males the hard work of cutting big logs with axes. The Yenadies have now become experts in felling trees flush with the ground and trim them so well that they have excelled the other castes in this work. It is observed that the fellings carried out by a Yenady are far better than those of Raddies or Malas, so that this race has now become very useful to the department in this respect. Each cooly works for 6 hours in the summer and eight hours in the winter, and earns from four to six annas a day. This work is done by private Yenadies, who reside in villages all over the islands, and no Government Yenady is employed on this work.

THEIR CONNECTION WITH THE TROLLYING OF FUEL.

In previous years fuel was brought down from the felling area to the canal bank in carts drawn by bulls or buffaloes. This process is not only slow but also very expensive. A large quantity of fuel could not be brought in unless innumerable carts were engaged. Regularity could not be had under this system owing to various causes. It has consequently been done away with and a tramway was introduced in the year 1889. The gauge is two feet and trucks are pushed by men. It is not known how the Government Yenadies were first made to consent to do this work. But it is a fact that no other man will undertake to do it because the work is so hard. These Yenadies have been doing this work ever since the tramway was introduced and they have now become accustomed to the work. Every day these men can be seen working at the tramway making three or four trips according to the distance they have to trolly. They make four trips a day up to a distance of a mile or a mile

and a half and make only three trips if the distance exceeds the above limit. Every truck carries from ⅜ to one ton according to the class of wood, and on an average they get Rs. 0-3-6 for every ton of fuel they trolly. This way of trollying brings the fuel quickly to the canal bank, and it is besides cheap. Last year about 7,500 tons of fuel was trollied with the aid of these Yenadies, and had it not been for these men, such a large quantity of fuel could not have been sent to Madras to meet the demand there.

Some experiments were made to haul the trucks with bulls and buffaloes. Three or four loaded trucks were attached and yoked to a pair of bulls or buffaloes. These animals were unable to keep straight on, and many a time derailed the trucks by dragging in the wrong direction. It was some time before they could be brought round to do this work, and later developments showed that the heavy dragging caused sickness and casualties among the live-stock. One after another they died and the hauling of wood by animals had to be stopped. Hence, recourse had to be had again to Yenadies, as the dragging of trucks by bulls or buffaloes was an utter failure.

The success of trollying of fuel is entirely due to the working of the Yenadies. Their usefulness to the department has been recognised by the Forest Department to which they form a necessary adjunct. Their services are indispensable.

REMUNERATION BY GOVERNMENT.

In addition to the daily wages given for the work done, the Government grants twice in a year presents in the shape of grain and cloth. In a year, a family gets 3 toms or 112 Madras measures of paddy and 38 cubits of cloth. This sort of encouragement by the Government gives the Yenadies an inducement to stick to the department—indeed, it is a very benevolent act on the part of Government to this neglected class.

In previous years a technical class was opened to teach the Yenady youngsters basket-making, but none learnt the art. A barber was engaged to shave these men, but his services were not utilized as they had no inclination to keep themselves clean. One

of these is now taught to wash clothes, and it remains to be seen how he will acquit himself. The Hospital Assistant at Sulurpit a station about 15 miles away, visits Sriharikota twice a month to treat the patients among the Yenadies. Originally they had a great aversion to English medicines, but now they are willing to submit themselves to English treatment. During the time of settlement of Sriharikota Reserve, the Settlement Officer was kind enough to allow a concession to these Yenadies, *viz.*, free access to the reserve, and to the use of such fruits, roots and leaves, as are generally eaten by this tribe.

The Government in its order No. 837 of 10th August 1881, directed that 75 Yenady men with families should be taken into its service, which was accordingly done. The above 75 families have now been reduced to 47 families. As civilization advanced among them, some of them gave up the service of Government and became independent. They are now employed by ryots in tending cattle, in cultivating land, and in other menial services.

In general, the services of the Yenadies to this department are invaluable and indispensable. They therefore deserve to be treated kindly and encouraged in their work. Efforts are now being made to increase the number of their families and to show every kind of concession to members of the tribe.

C. BALLAYYA NAYUDU,
Forest Range Officer,
Sriharikota.

KOTHACHENU :
31*st May* 1910.

THE FEDERATED MALAY STATES' FORESTS.

Except for the rubber estates and paddy-lands, the whole country consists of wild evergreen forests, swampy and interspersed with steep hills. Metalled roads are scarce but well laid out ; so that with checking stations at all important cross-roads and guarding the entrances to all towns, control of forest-produce is fairly easy.

Reserves.—The idea is to reserve approximately ten per cent of the country for forest purposes. The system of demarcation followed out is the line of pipes laid down by the surveyor and an 8′ clearing all around where the reserve is not bounded by a

metalled road. The primary idea, I believe, was not to work the reserves at all till all State lands had been worked out. But this method has evidently been abandoned, as certain reserves are now being worked by contractors specially licensed. Trees are marked by district forest officers under improvement fellings, in two places. Contractors have to fell between these two blazes and as low as possible, *i.e.*, just above the end of the buttresses. Conversion is carried out on the spot or at the kongsie, and the timber is dragged to the roadside by buffaloes (almost wild). After this the system is the same as for State land, below, except that the royalty rates are slightly higher.

State Land.—Timber and firewood contractors take out licenses under forest rules 2—4 and in forms 1 and 2. On the license is stated the locality and amount of deposit made in the office. When first taking out a license, they are compelled to make a deposit in proportion to the number of coolies going to work. The licenses are renewed monthly; and each workman must have a sub-license in form 2 issued by the nearest checking station guard. He now starts work and can fell what he likes, provided he does not fell any tree below the girth (3′—7′ 6″ depending on sp.) limit stated in forest rule 11. His timber, in the round or converted, is dragged by buffaloes to the roadside, and from here it is carried on carts to the destination—some large town or perhaps estate. At the first checking station it comes to, it is stopped, measured, and hammer-marked. A removal pass in form 7 is written out in triplicate by the checking station guard. One copy is given to the cartman, one is taken away by the ranger or forester on his rounds, and the third forms the butt. The contractor must come in to the district forest office by the first week of each month to pay his royalty and have his license renewed. Only in extreme cases is the royalty deducted from the deposit. When the contractor stops working, the area is inspected to see there is no waste, and he gets back his bare deposit.

Minor Products.—Licenses can be taken out on the same conditions as for timber. Under forest rules 8 and 9, special permits may be issued for forest products other than class I timbers by

the Conservator in form 3. In such cases royalty is not collected, but the following fixed rates are charged :—

	Per man per month.
Timber-cutters	$4.00
Cutters of mangrove firewood or burners of mangrove charcoal...	$5.00
Cutters of firewood or burners of charcoal from class II timber other than mangrove	$3.00
Collectors of other forest products	$1.00

General.—No class I trees may be cut for conversion into firewood, nor may any tree be felled within a radius of 10 chains from the crest of any prominent hill. All licenses are "not transferable." All "Gutta-percha" and "Getta Rambong" trees are specially protected, *i.e.*, the express written permission of the Conservator must be got to do anything to them, under forest rule 10.

Miners have a free right to firewood of class II spp., and Meranti and Petaling timbers on State land within a radius of 10 miles from their mine. All such woods taken must be stacked actually at the mines. In return the department used to get a quarter share of the opium duties, but this was stopped in 1909.

Alienated Land.—Only lands alienated before 1897 have the right to issue their own passes. In all other cases the usual license must be taken out.

ROYALTY TIMBERS.—Class	I A,	$5.00 (round)	or $3.00 (square)	per ton
,,	I B.	$3.00 ,,	$2.00 ,,	,,
,,	I C.	$2.00 ,,	$1.50 ,,	,,
,,	II	$1.00 ,,	$0.50 ,,	,,

Poles according to girth = $0.50—$4.00 per 100.

Firewood.—Mangrove	=	$1.60 per 100 pikuls.
Other	=	$0.30 per ton measurement.
Charcoal.—Mangrove	=	$0.15 per pikul.
Other	=	$0.10 ,, ,,
(CANES) RATANS.—Dahan under 10′	=	$1.00 ,, bundle of 20.
Over 10′	=	$2.80 ,, ,, ,,
(WILD RUBBERS) *Getahs.*—Jelutong	=	$0.80 ,, pikul.
Grit	=	$10.00 ,, ,,
Rambong	=	$20.00 ,, ,,
Sundek	=	$40.00 ,, ,,
Taban	=	$50.00 ,, ,,

Bamboos, according to girths and lengths, $0.30—$1.50 per 100.

Damars, $0.20—$2.00 per pikul.

(1 Pikul = 103 katis = 133⅓lbs. and $1.00 = Rs. 1-12.)

Working Plans, etc.—The "Federal Bakan Forests," which comprise the coast mangrove forests (about 100,000 acres) of Perak, are worked under the method of clear fellings with a rotation of twenty years and a minimum girth for felling of 12". The demand is for firewood, small piles and fishing stakes. The average output per acre is 240 pikuls. Tannin is extracted in a crude way (somewhat after the method of cutch-extraction by villagers in India) by the local fishermen for their sails and to a slight extent in Taiping. Export is done in "tongkans" (Chinese junks) and "sampans," and is greatly assisted by the fine network of creeks.

In the U. Selangor District the Rautan Panjang and Kuang reserves are undergoing heavy improvement fellings in favour of Getah Taban (Gutta-percha). Roughly, 100 acres in each is being gone over a year.

At P. Tanjong there is a Government rubber estate run by the forest department. About 3,000lbs. a month of dry rubber is being turned out a month just now at about a shilling a lb., all told. The trouble is labour; as, for example, if more tappers could be got the yield would probably go up another thousand or two at once, I believe. There are two or three other experimental plantations of this sort in other States of the Federated Malay States.

In the P. Tanjong reserve there is a large hardwood plantation in direct charge of an experienced forester.

Working Expenses, etc.—Local labour is dependent on the Malays, who are an indolent, "care-nought" set of folk; and even these can only be procured at .40 to .50 cents a day. Boundary cleaning (8' wide) averages $8.00—10.00 per mile. Inspection path with rough bridges and all, average $30—50 a mile. A few rough figures as the following might not be out of place:—

				c.ft.
Class I A., Penak (or Chengal),	av. girth = 11' 9·4"	.Exploit size,	7' =	115·5 per tree.
,, I B., Merban	,, ,, = 13' 0·1"	,, ,,	6" =	55·7 ,,

C. G. YOUNG,
F.M.S. Forest Service,
U. Selangor District.

REVIEWS AND TRANSLATIONS.

THE TREES AND SHRUBS OF THE INDORE STATE.

[CONTRIBUTED.]

The "Trees and Shrubs of the Indore State" is prepared on the lines laid down by Messrs. Rogers and Witt for the forest flora of the Berar Circle, but excludes all climbers and herbaceous plants. The omission of all climbers from the body of the work, because the author has not identified *some*, and the mention of the most important in the introduction, will not commend itself to forest officers.

In physical features, geology and climate, Indore has much in common with Berar. Each is intersected by considerable hill ranges showing much the same geological formations, among which the Deccan trap occupies the chief areas of exposure. Each has large areas of cotton soil which cultivation has mostly long since taken possession of and where forest, if it exists at all, is composed chiefly of Babul. Each has under 40 inches of rainfall, or, probably, on the hills, rather more. The area, however, of Berar is 17,710 square miles, while that of Indore is only 9,500 square miles, while the Melghat, where the hills rise to between 3,000 and 4,000 feet, would, *ceteris paribus*, prove a richer botanical district than the Vindhyans of Indore, which only attain 1,500 to 2,500 feet elevation.

It is, therefore, not surprising that, although the floras are nearly identical, the number of species recorded in Indore falls short of that of Berar. As, however, the Indore list claims to be nearly complete for the trees and shrubs, a claim not put forward by the authors of the Berar list, the discrepancy is more marked than would be anticipated.

In the Indore list only 181 species are enumerated altogether, and some of these (e.g., *Leea macrophylla*) are hardly woody and, if we exclude some 14 undoubtedly exotic species, there are only 167 species. The Berar list treats of 190 indigenous trees and shrubs (omitting climbers). It is therefore possible that the list is not as

complete as its author claims, a proposition which is supported by the signs of manifest hurry with which it has been compiled. The book is crowded with mistakes, besides those ascribable to the printer. It is presumably written for more or less unbotanical readers, but such quasi-scientific books' should at least avoid using scientific terms in a wrong sense. A drupe is here defined as 'a fleshy 1-seeded fruit,' and there is the greatest confusion between flowers and clusters of flowers, fruits and clusters of fruits. Thus the flowers of *Adina cordifolia* are described as 'yellow globose,' the fruit of *Anogeissus* as 'small brown globose,' the fruit of *Stephegyne* as 'a small globose rough many-seeded capsule, black when ripe,' the fruit of *Morinda* as 'ovoid or globose.' Even for popular use some of the descriptions seem to be particularly unfortunate. Even if not botanically wrong, it gives a very misleading impression of the apocarpous nature of the fruit of *Michelia Champaca*, merely to say that it 'contains a number of seeds, the size of a small pea.' Again, the flowers of *Cratæva religiosa* are described as in 'racemes' instead of in corymbs, the flowers of *Boswellia serrata* as somewhat like 'Lily of the Valley,' and the drupe of *Elæodendron Roxburghii* is described as 'the size of a small cherry.' The actual cubic contents may, indeed, be the same for the case of a particularly small cherry but, as the drupe of *Elæodendron* is oblong, the description does not seem very illuminating.

Under *Cochlospermum*, we read that the tree is known as the silk cotton or candle tree. *Saccopetalum tomentosum* is said to have a 'purple fruit 3 or 4 together.' Here the purple black ripe carpels appear to be taken as separate fruits, but they are frequently more than 4 together. The fruit of *Grewia tiliæfolia* is said to be the size of a pea, but nothing is said of its very marked didymous character. The fruit of *Grewia scabrophylla* is described as *small*, whereas it is larger than that of all the other Grewias enumerated. The fruit of *Melia Azedarach* is said to be like that of *Melia Indica*, whereas it is quite different. The fruit of *Eugenia Jambolana* is spoken of as 'a black edible plum,' an atrocious description for a fruit without a stone !

The printer's devil is no doubt responsible for the statement that the scent of *Lantana Camara* 'resembles ribs or flowering currant' and, under *Clerodendron serratum*, 'seeds common.'

The author's adherence to his model is sometimes too close. Thus the mistake of including *Embelia* in *Rubiaceæ* noted in the Berar list is repeated in the Indore list? It is difficult to say why the order of the last three families is *Gramineæ*, *Viteaceæ*, and *Pandanaceæ*.

There is nothing very striking in the flora itself, which is of the ordinary dry Deccan type, with a small sprinkling of plants more characteristic of the Rajputana and Punjab area. Thorny species generally abound. There are three species of *Capparis* enumerated, and a fourth, *Capparis sepiaria*, would be expected to occur. Nine species of *Acacia* are mentioned, but no reference is made to the two varieties of Babul which have been botanically discriminated by Mr. Rogers in Berar and are there popularly known as 'Telia' and 'Kaoria.' Mr. Rogers now believes these to be distinct species. The beautiful *Nerium odorum* is 'found wild in abundance' in some of the ravines.

Much of the value of local lists is lost when care is not taken to carefully discriminate between supposed indigenous species and those believed to have been introduced. *Thespesia populnea* is not specifically mentioned as exotic, so that doubt arises whether *Pterospermum acerifolium* 'reported from Rampura' is believed to be indigenous. *Poinciana elata* is apparently considered indigenous.

Melia indica (the name adopted for the Nim) is said to exude 'at times from the root, artificially or spontaneously, a copious sap or toddy used in medicine.' This is, I believe, new.

SHIKAR, TRAVEL, AND NATURAL HISTORY NOTES.

FISHING THE GIRI TRIBUTARIES.

Now the following few notes may be of use to those unfortunates—who like myself in April 1909—with all their plans laid and leave limited, arrive to find the Giri a hopelessly unfishable flood; a condition too, which may remain in force during the whole period of their stay on the river. For there would appear to be no doubt that the conditions of the Indian climate are changing, and not for the better from the point of view of us brothers of the angle. Read any old fishing records, the Giri, Tangrot, etc., and one cannot help noticing how of late years, March, April, May and June have become more and more unsettled as regards weather. And if one arrives at a river such as the Giri and finds it unfishable, well one's natural instinct is to hope that it'll clear in a day or two. And if it doesn't, it is not so easy with limited leave, to pack up and be off to pastures new, and besides, anyhow if one is bent on fishing, the weather being adverse is just as likely to effect other waters as much as those one is on. And if the 14 feet rod, with all its component tackle, is not to be used, there is no reason why the little trout rod should not have its outing. And sometimes men are inclined to despise an afternoon's catch, of say half a dozen mahseer, averaging nearly a pound, but why this is so it is hard to say. For India read Scotland, and would such a creel taken from the burn be despised? I hardly think so. Perhaps if taken from the salmon river, angling for fish, this might be so, and perhaps there is somewhat of this feeling in angling for mahseer; since they run big, the zest of catching small ones is thereby cloyed.

Now to take the Giri tributaries, of which there may be said to be seven that join it in its fishable reaches. Reading from Kharganu down the river to Rajghat, their names are the Peroo Ashni, Koal, Nait, Palar, Joger and Jalal. The first and the last from a fishing point of view may be wiped out entirely, numbers 4

and 5 being the only ones that have any real claim on our sympathies. The first three however, are those of most interest to the man who just drops down for the week end to Kharganu, for they all lie within two miles of the Fishing bungalow. The Peroo joins from the left bank, a short way above the village and as I before remarked is beneath our notice. The Koal, two miles below the bungalow, flows in on the right and is hardly worth the trouble of working up. Though but a trickle at its junction with the Giri there are some fair pools, a little way up, and fish of quite decent size are occasionally seen. The main feeder of this stream is used at Barogh, for watering the engines, and always carries a good flow of water, as can be seen below the line. About two miles below Solan, there is one quite big and deep pool, surrounded by high rocks, in which can be seen numbers of fish, from 1 lb. down, mostly kalabanse, though there is generally a sprinkling of mahseer among them. The Ashni or Simla stream flows directly below the bungalow, and its bed forms the track for the last four miles of the route down to Kharganu. Its main feeder takes its rise close below Chota Simla bazaar, and the road from Simla to the Giri follows the bed of the stream right down to its junction with the river. It is not a satisfactory tributary to fish, though, as its bed is too broad and pools never seem to be of any depth. However in the gorge above Tikri village, and a short way below where the path from Salogra comes down, are one or two pools of better size, and fish of 2 and 3 lbs. do work up as far as this in the rains. I have heard of one or two keen anglers from Solan going down here in the monsoon, and having fair sport with worms. The junction of the Ashni with the Giri is a most uncertain quantity, sometimes fishing well, though there is no doubt that of late years it has not been as good as formerly.

The first two marches down the Giri reveal no tributaries, or rather streams that can be dignified by such a name, and it is not till one approaches the third camp at Koorkna, that the Nait brook is crossed. This to my mind is the most delightful of the seven. Though not quite so big or full of fish as the Palar burn, it has one great advantage over the latter, in that it practically never dirties.

It wells direct from the heart of the Chur, its waters crystal clear and black, never affected for any length of time, even by the heaviest rain. Unfortunately in the last year or two the Nait has split into several channels for its last couple of hundred yards, and falls into the Giri in a series of small trickles, instead of plunging a solid volume of water into the main river, and forming thereby a junction such as would delight the heart of any angler. And the Nait too holds fish of no mean size. I saw an eight-pounder taken out of a basket cruive some distance up stream, and also I was vouchsafed a glimpse of a fish in the waterfall pool that I estimated to be at least half that weight again. And this waterfall pool is perhaps the most fascinating spot in the river. I was told of it in vague terms when passing through Anu village, a most respectable old man assuring me that if I went to this pool, I should catch plenty of fish. His use of the word catch, was the only part of his speech that betrayed senile optimism, the rest was solid fact, though at the time I was inclined to doubt it. The pool lies something under a mile up stream, the fall only being a glissade over some five feet of shelving rock, but the water was evidently of great depth, and to my astonishment the pool was packed with fish when I arrived. At first they were most unsuspicious, but this did not last long, and with one's invariable luck in these cases, it was from the ranks of the two-pounders that my first victim came, and not from those of the six-pounders to whom my lure was really tendered. By climbing on to the rock at head of fall, and lying down, I managed to cast a fly-spoon for some time without disturbing them. And I must say their welcome was most cordial, a splash and plunge answered the fall of the bait each time, and though tugs were numerous somehow, at first I could not hook one. The landing of the two-pounder, who had to be played out down the tail of the rapid into the next pool, before he could be lifted forth, seemed to have affected their appetites, and after another fish of a pound had followed his bigger brother, not a fish was to be seen in the pool. Arriving here another day I found the water alive with big fish on the feed, the chilwas by twos and threes were dashing at the fall and making attempts to ascend

which were invariably it seemed doomed to failure. But whenever a chilwa fell back, instead of trying again, he turned tail at once and in a series of leaps fled down the centre of the pool, doing a species of obstacle race with the gaping mouths of several mahseer as his pitfalls. Having no chilwa, and seeing no chance of catching any, unless I thrust myself into undue prominence, I cast about for a substitute, and discovered among the rocks, a little weedy pool inhabited by several small frogs. Though walers to dive and hide one was at last dragged forth, and struggling frantically was impaled on the hook by the loose skin of his back. Crawling on to my favourite rock froggie was gently deposited below the fall, where, though I could not see him, I could feel him kicking out right manfully. Very few seconds elapsed before there came a tug, and froggie dragged off by a hind leg was gulped down by a hungry mahseer. Another stern chase and a second frog was offered, to be accepted in the same cordial fashion. A third one however was refused, and the run of chilwa having stopped, the fish had apparently gone off the feed. It was then I saw the big fish chasing fry at the tail of the pool, almost the whole of his bulk showing out of water for nearly 20 seconds. Eventually a two and a half-pounder succumbed to my fly-spoon, but I had expected better sport than this and was disappointed.

About three miles up the Nait lies a fair sized and very deep pool, formed years ago by a small landslip. I toiled up to this, but should not advise anyone imitating my example, since the going is hard and the resultant gain, *nil.* I was assured that the pool held immense fish, but this I do not believe, since with the exception of a diminutive labeo, there was no sign of life in the pool, and as I watched for a long, and fished for a short time, some sign would have been vouchsafed, had mahseer been present. Nor did the Nait brook seem to hold many fish as far up as this, even though there was a certain amount of good water there seemed to be a lack of tenants for the same. The camp below Koorkna is Seum, and just below here runs in the Palar burn. It is a good bit bigger than the Nait and is by far the largest tributary the Giri receives. It also rises

on the slopes of the Chur, but its waters lack that black clearness that is so characteristic of the smaller stream. It forms a most excellent junction with the Giri, and here, if the big river be dirty and the tributary clear, one is almost certain of running a fish or two. And for several miles up the Palar burn fish are to be caught. I have caught them over a pound, two and three miles up. The climbing is not so difficult or so rough, and the bed of the Palar burn is broader and the cliffs far less precipitous than those that line the Nait brook. The first really good pool, comes about a quarter mile up with a rock in the centre, though I have never moved a good fish here still it is deep and there are some nice lies, so that it should always be given a trial. The biggest fish that I actually caught in the Palar was 4 lbs., but I have moved much bigger, and had one chap of over 10 lbs., follow my fly-spoon right across a pool. I fancy that a little mild poaching goes on in this stream as well as in the Nait, but it is not really enough to worry about, although all the tributary streams are supposed to be in the hands of the Giri Club. However, if anglers will destroy cruives whenever met with, this should suffice, as in the cold weather when no sportsmen are about, only some kalabanse are destroyed probably, since the traps are very few and far between, these tributary valleys being but sparsely inhabited, and the Giri can afford to part with any number of labeo. I fancy that these streams would give some very pretty sport using fly, though I rather doubt its proving more successful than a fly-spoon. Six miles below the Palar burn comes the Jogar tributary, a stream that unfortunately breaks up very much at the junction. I never had leisure to explore up it so cannot say whether or no it holds fish, but it carries a fair volume of water when running as one stream, and might repay investigation for a short way up.

The Jalal is a snare and a delusion. Looked at upon the map it would appear to be the most healthy tributary Giri receives, it has a fair sized catchment area and is of good length. But I fancy it is not perennial, or if so, that the springs that feed it are so small and weak that the waters therefore never reach the Giri. Even after fairly heavy rain, the bed of the Jalal was stone dry at

Sattibagh. Up higher there were a few pools so I was led to believe, and the trickle that is dignified up there by the name of stream, is all run off in irrigation cuts.

Opposite Sattibagh a small rivulet falls into the Giri, which has its being in the Ranka Tal. This splendid lake is full of mahseer, murral and muggers but is held sacred by the Sirmoor authorities and no fishing therein is allowed. If it was open like Bhim Tal, etc., the angler on the Giri might vary his sport with some very pretty loch fishing for a day or two.

Sirmoor Tal lower down the river never held fish, being perched high up among the hills, now however it is dry and under cultivation.

Below Sattibagh to its junction with the Jumna the Giri receives no other stream that can be dignified with the name of tributary.—(*By Skene Dhu, in the Indian Field.*)

THE DESTRUCTION OF WILD ANIMALS IN THE CENTRAL PROVINCES DURING 1909.

[CONTRIBUTED.]

The number of persons known to have been killed by wild animals in the Central Provinces during the year ending on the 31st December 1909, is 220—a slight decrease from the last year's figure. Balaghat heads the list with 45 deaths; only two districts can submit a blank report. Two man-eating tigers are reported to have been killed; but there still remain the following: the Korba Zamindari tiger, the Gariaband tigress, both in Raipur district, the Kothari panther in Chanda, and another in Balaghat, and a tiger in Baihar (Balaghat district). The rewards offered for shooting these amount to Rs. 1,850. The native shikari usually shifts his camp when a man-eater appears near his village. One, however, while stalking deer in Balaghat along with a friend, was himself stalked by a tiger and taken to his last hunting ground. "In the same district another man-eater, said to be a tigress, charged a line of nine men, who were returning from cutting wood and killed one of them. A military officer met his death from a tiger he

had wounded in Jabalpur. A male panther in the Dhansua Range of the Balaghat district is said to have confined his kills to girls and young women."

There were only 20 deaths from bears this year against 31 in 1908. An elephant in Drug and a wild cat in Jabalpur each account for one victim. The reports are lamentably remiss in details. The Central Provinces police officer essays no heart-rending descriptions of torn limbs, mangled bones, and one is left in ignorance of much that one would know. The two tragedies are simply, almost baldly, recorded—"elephant one," "wild cat one."

The Lauder Brunton treatment was used successfully in 58 cases of snake-bite; but in no case was the identity of the snake established. There were 1,383 deaths from snake-bite against 989 last year.

The cattle mortality attributed to wild animals fell slightly to 4,124. In five districts bears are said to have killed cattle.

One commissioner recommends the giving of rewards for the destruction of pig, which undoubtedly is the *bête noir* of the villagers. Mr. Craddock, however, considers that the people need no stimulus to slay the pig, and that the system obtaining in some districts of requiring license-holders to produce boars' tushes should be given a further trial.

MISCELLANEA.

THE UNITED PROVINCES FOREST SCHOOL.

The final examinations were held at Naini Tal at the end of June. The quality of the students was exceedingly good. All of them, seventeen in number, succeeded in getting certificates and ten of them obtained over 75 per cent of marks. Mahomad Ali, Forester, from the Siwalik Division, was first with 91 per cent. Five of the students belonged to the Western Circle, five to the Eastern Circle, and one was on deputation from each of the following :—Naini Tal, Almora and Garhwal District Forests, Tarai and

Bhabar Government Estates, Kashipur Estate, Tehri State, and Kashmir State.

The training of the class reflects great credit on the officer in charge, Mr. Mathura Prasad Bhola, Extra Assistant Conservator.

At present the duration of the class is for eight months only, but it is proposed to increase it to eleven months, and to have permanent school buildings at Khurpa Tal, about four miles from Naini Tal. The demand for trained subordinates is increasing so rapidly, that the number of students is to be raised to 30 annually.

THE PROPAGATION OF EUCALYPTUS.

Information has been received from the Curator of the Antigua Botanic Station to the effect that experience seems to point out that the propagation of *Eucalyptus* there, is, if special methods are not adopted, a somewhat difficult process. Recently, there has sprung into existence a demand for these trees, and efforts have been made to raise them in fairly large numbers.

At first, the usual method of raising seedlings was adopted; the seeds were sown in boxes, and the young plants potted when about 2 inches high. With this method, the mortality was very great, not more than 2 to 3 per cent of the plants being saved.

In consequence of repeated failures to raise plants by what could, perhaps, be called the orthodox methods, different ways were tried, the soil used in each being a somewhat open loam. The greatest success was obtained when the seeds were sown in small pots, the diameter of which was from 2 to 2½ inches. Two to four fertile seeds were placed in each; the first seed that germinated was left, and as the others grew they were pulled up and destroyed. Whenever water was required during the time that the seeds and young plants were in these pots, they were placed in a bucket containing it to the depth of their own rim. No water was given overhead; protection from heavy rains was provided. As soon as two leaves other than the cotyledons were formed, the plants were carefully transferred to pots having a diameter of about 6 inches. Afterwards, the first watering was

performed as described above, the subsequent ones being done with a watering pot from overhead. Little or no shade was given to the seedlings. To protect the seeds from ants, which do a great deal of damage, if no precautions are taken, the soil surrounding the seedlings was well soaked with water containing a little kerosene.—*(Agricultural News.)*

TURPENTINE SUBSTITUTES.

The manufacture of turpentine substitutes in Germany is proceeding with considerable activity and commercial success; this technically prepared turpentine being obtained by the distillation of heavy petroleum from Borneo. It is not surprising that a fairly satisfactory turpentine substitute should meet with ready sale, inasmuch as ordinary American turpentine is now quoted at about 85 marks per 100 kilos, while the substitute can be had for 32 marks, and even less. The odour of the turpentine substitute is not at all like that of ordinary turpentine, and it is doubtful whether it can be used for pharmaceutical purposes. On the other hand, it is being used in the paint trade in increasing quantities. Turpentine substitute was brought out in England about five years ago in consequence of the efforts of a powerful British company controlling the Borneo oil-deposits to find an outlet for their petroleum. German manufacturers promptly entered the business, and there is lively competition between various marks now offered for sale.—*(Indian Trade Journal.)*

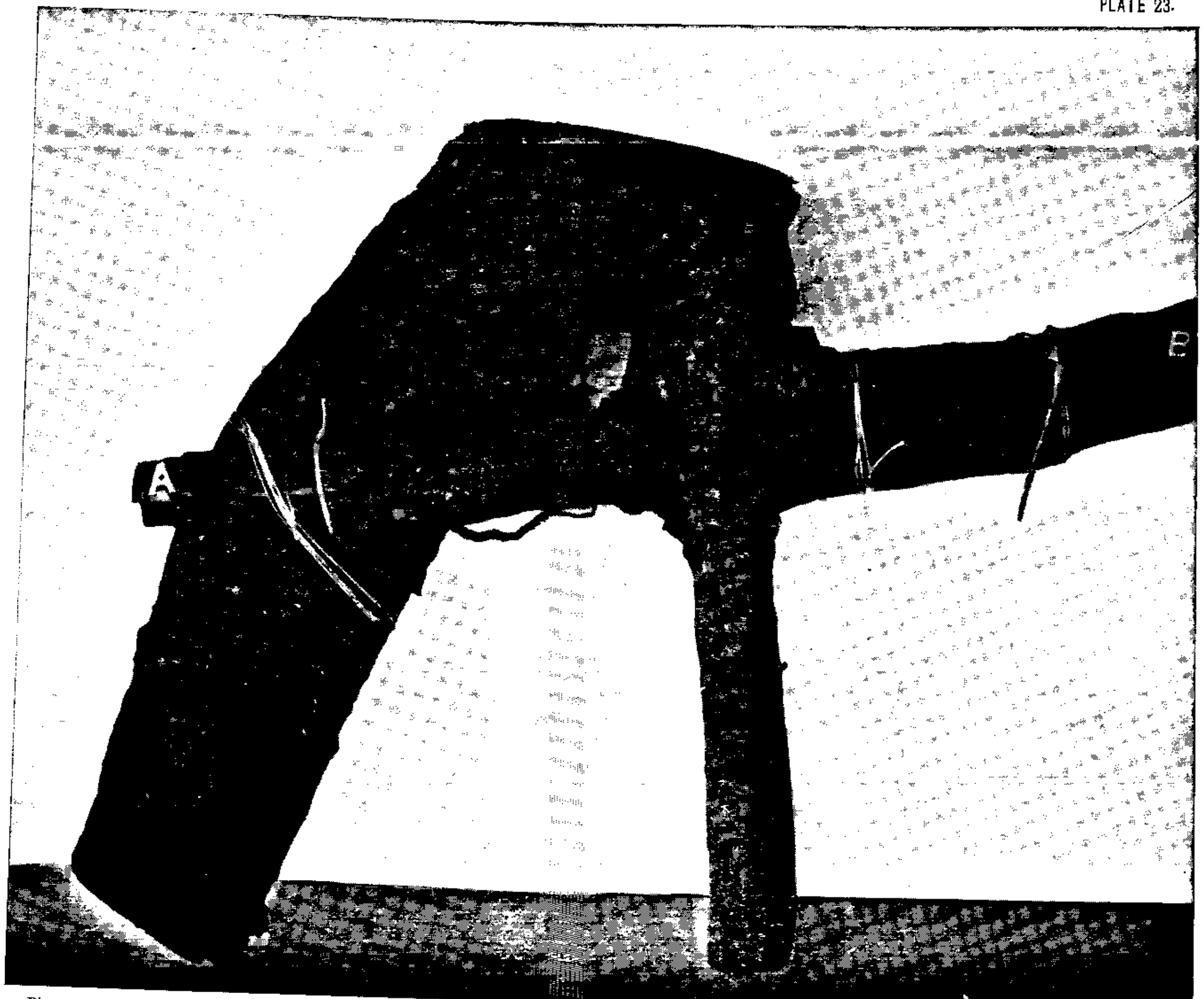


Photo.-Mechl. Dept., Thomason College, Roorkee.

ROOT INFECTION OF TRAMETES PINI.

Root of healthy and diseased pines in contact showing the position in which they were found in the soil. (A. B. healthy root).

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OCTOBER, 1910.

FORESTRY EDUCATION IN INDIA.

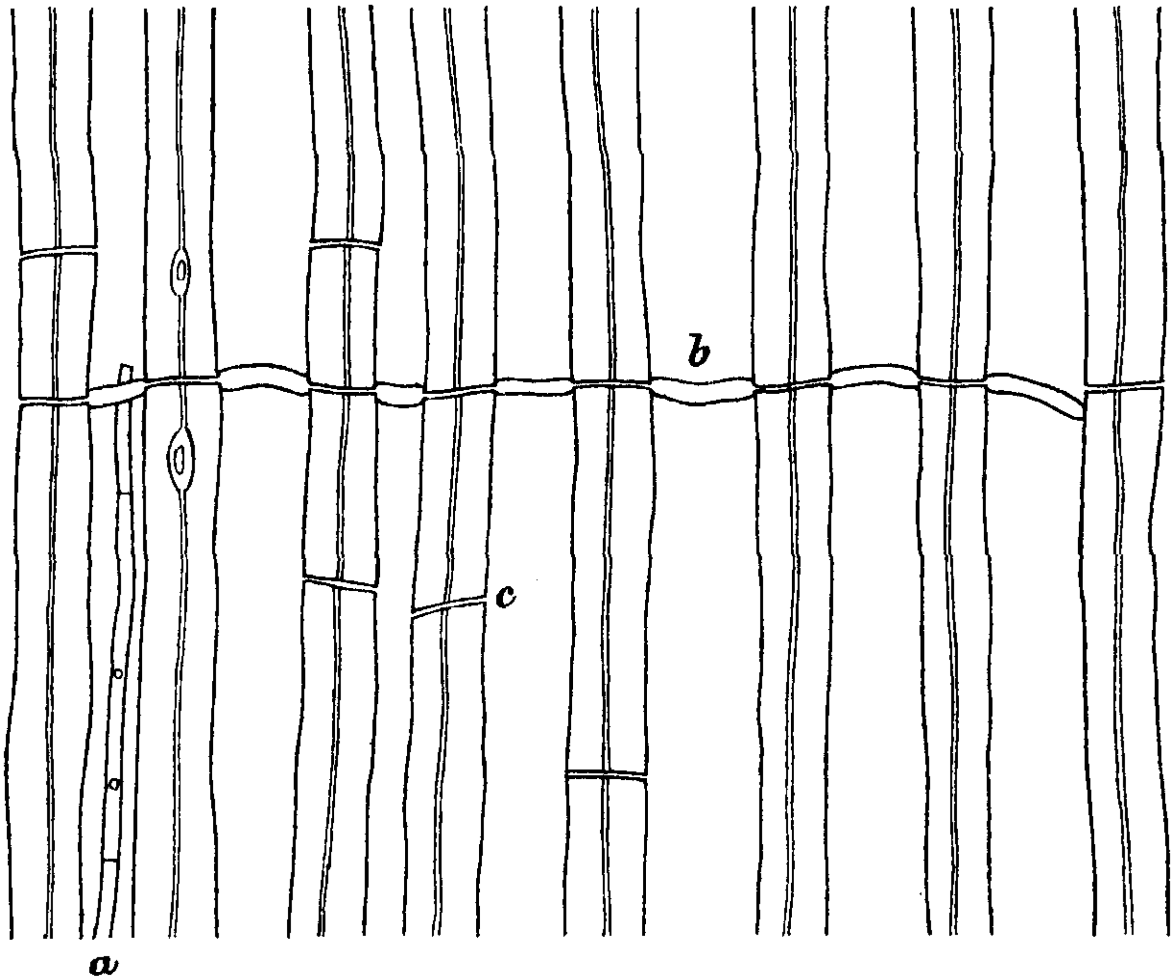
For many years past every endeavour has been made to induce the rulers of Native States and other owners of forests in India to realise the advantages of scientific forest management, and in a great number of cases selected officers of the imperial and provincial services have been placed on deputation in order to organise the forests and to place the management of them on a proper basis. These efforts have had a marked result, and there are to-day few states in which considerable interest and attention is not being paid to this important question. But having obtained these results, we are now in fact hampering the development of the forest on scientific lines by inadequate arrangements for education in scientific forestry. This may produce most disastrous results and undo a great deal of the good which has been done by quenching the interest which has been aroused. The policy has been to awaken interest in the management of the forests on scientific lines and to instil the advantages of such management by the deputation of Government officers. One of the principal aims of this policy, *viz.*, that the states should send their own men to be properly

trained in order to insure the continuity of the work on proper lines, has been in many cases attained. Having attained this important aim, it is much to be regretted that sufficient facilities for forest education are not being granted to candidates from native states. For the higher ranks the Imperial Forest College is the only institution in Northern India, where men can be trained, and we believe that last year no less than 26 nominees from native states were refused. If this sort of thing continues, it is certain that there will be a set-back in the present progress.

It has been realised for some time that it is not possible to train at the Imperial Forest College all the men required for the whole of India. A separate Forest School for rangers in Burma was accordingly started at Tharrawaddy some years ago, and all rangers for Burma are now trained there, the Imperial Forest College being to this extent relieved. The College is swamped by Madras men who number 23 at present out of 60 students in the senior class. In addition there are a number of students who aspire to direct appointment for the Provincial Forest Service and who ought not to have anything to do with the ranger class. The obvious remedies have been proposed, *viz.*, the establishment of a separate school for rangers at Coimbatore in Madras and the institution of a separate course for candidates for direct appointment to the Provincial Forest Service. We are unaware as to what stage these proposals have reached, but it is extremely urgent that both should be adopted without delay. These arrangements would relieve the pressure for the time being, and the question as to whether it is not necessary to establish still another school in the Central Provinces for the training of rangers could be considered afterwards.

It is obviously our duty to arrange for reasonable facilities for the training of native state subordinates to carry on the work which has been initiated by us and the present state of affairs should be remedied immediately.

The congestion at the Imperial Forest College too, does not only affect the native states, as we understand that several Government candidates have been refused admission to the next course and in addition not a single private student has been



ROOT INFECTION OF TRAMETES PINI.

Radial section of root of Pinus excelsa with hyphae of Trametes Pini—

a. Hypha running longitudinally. ;

b. Radial hypha piercing the cell walls;

c. Holes left in walls after hyphae have disappeared.

Photo.-Mechl. and Litho. Dept., Thomason College, Roorkee. Zinco., September, 1910.—No. 6936-1.925.

admitted. A supply of private students is a most valuable asset to the department to fill up vacancies which occur unexpectedly. If no such students are forthcoming, it means that such vacancies cannot be filled until three years later, and the work of the department is to this extent hampered.

The demand for education in scientific forestry is growing apace. In the United Provinces a small class for training foresters was started three years ago. It was intended for about 12 students annually. For the next course it has been necessary to enlarge the class to 30 students and still at least as many again have been refused admission. This is an indication of the rapid way in which the demand for training in forestry is already increasing. The Forest Department is a young department, and it must continually expand in the future, for progress can only be maintained by more intense management which necessitates an increase of a staff. Private owners too are beginning to want trained men for their forests, and as we have already stated, the demand by native states is ever on the increase. With the certain increase in the demand for trained forest officers of all ranks in front of us, it behoves us at once to take steps to make it possible for sufficient men to be trained. Any delay in doing this will set back the development of the forests of India proportionately.

SCIENTIFIC PAPERS.

ROOT INFECTION OF TRAMETES PINI (BROT.) FR.

BY ABDUL HAFIZ KHAN, ASSISTANT TO THE IMPERIAL MYCOLOGIST, PUSA.

In the year 1904 a serious disease was reported in the blue pine or chil (*Pinus excelsa* Wall.) forests of the Simla Division. Specimens of the diseased pines having sporophores of a fungus attached to the stems were sent to the Imperial Mycologist by Mr. Mayes, Deputy Conservator of Forests, and the fungus was identified as *Trametes Pini* Fr., the cause of the well known ring scale of pine in Europe.

In October 1908 the attack was again very bad, and Mr. Hole, the Imperial Forest Botanist, who was looking into the matter there, wrote that the roots of healthy and diseased trees while growing underground were frequently found coming in contact with each other and fusing entirely, and that this fusion naturally suggested the possibility of infection taking place by the passage of the parasite from the diseased roots into the healthy ones. In order to decide this point, Mr. Hole arranged for a series of specimens showing the healthy and diseased roots grafted together to be sent for examination to Pusa. In all seven specimens, each consisting of portions of a healthy and of a diseased tree, whose roots were in contact were received, one in October 1908, two in October 1909, and four in June 1910.

In every one of these cases sections taken from the roots of the healthy tree just at the point of contact with the diseased one showed filaments of *Trametes Pini* in the wood. This showed that the outwardly healthy trees were really infected by *Trametes Pini* and made it highly probable that infection had taken place below the ground level, a very interesting point in view of the accepted opinion that infection takes place only through wounds above ground.

As this examination was not enough to decide the question definitely, an attempt was made to discover hyphæ passing across from the diseased to the healthy root. For this purpose roots were selected which had become closely grafted together, and sections were cut in such a manner that the one section included the tissues of both healthy and diseased roots. In one case one hypha was clearly seen passing from the cells of the diseased root into those of the healthy one.

To determine the characters of the mycelium of *Trametes Pini* in the roots, a number of roots of blue pine dying from attacks of ring scale were examined. The hyphæ bore the cell walls freely and also enter through the cell pits. In fact, in one case one hypha was actually seen boring 9 cell walls from right to left one after another. The hyphæ are both thin and thick, septate and hyaline, except in the old stage when they are light-brown.

So far as has been noticed from the examination of these specimens, the hyphæ seem to grow equally luxuriantly in the heart-wood and in the sap-wood. The parasite produces a dark discolouration in the wood which is due to the cell contents being destroyed by the fungus and the empty cells refilled with resins. It also produces a decided change in the smell which can be easily detected when compared with that of a healthy piece of wood. All the trees having their wood thus discoloured are rendered perfectly valueless.

So far the examination had shown that *Trametes Pini* passes readily downwards into the roots and that when the roots of two pines come into close contact, as frequently happens, the hyphæ can pass from the wood of one into that of the other. There was as yet no conclusive proof, however, that infection of healthy trees could occur in this manner below ground, though some of the isolated roots sent were infected in the end furthest from the trunk and free from hyphæ at the end nearest the trunk thus apparently showing that the parasite was capable of travelling upwards from below towards the stem. In most of the other cases hyphæ were found at both ends of the root and even several of the so-called healthy roots sent contained hyphæ in all their length. Search was accordingly directed to finding a case where a diseased root was in contact with an apparently healthy root, belonging to a tree which was not affected by the disease in its above ground part, and to finding whether in such a case the parasite had succeeded in causing a localised infection of the sound root. After a prolonged search, one good case of this nature was found. It was a root belonging to a tree apparently quite healthy, but fused at one place with that of a diseased tree. Sections were then first taken from all parts of the diseased root and hyphæ were found everywhere in it, then from the healthy root just at the point of contact. Here hyphæ were found confined to the portion of the wood nearest the diseased root and extending about an inch above and below. The remaining portions of the healthy root were very carefully examined and no trace of fungus found anywhere else. Hence the parasite had been communicated from the diseased root, and it was certainly

a case of very recent infection. It may be mentioned that all the sections examined were stained with cotton blue which shows up the hyphæ beautifully and prevents their being overlooked.

There is, therefore, no doubt that infection by *Trametes Pini* may occur underground when the roots of diseased trees come into contact with those of healthy ones. Such a method of infection has not been recognised in any of the accounts of the disease available at Pusa. All say that infection occurs only through the wounds left by breaking off branches above ground. In Germany it is definitely stated that the heart-wood disease of pines due to this fungus never has its origin in the roots, but always comes from a branch stump.

The observations made by the forest officers in the Simla forest while collecting these specimens to send to Pusa quite agree with what has been found by microscopic examination. In the notes sent in with the specimens six cases are referred to in which a pine apparently healthy in its above ground parts was found with the rot due to *Trametes Pini* in the roots and extending upwards towards the stem to a greater or less distance. These were all probably cases of underground infection.

I should not fail here to express my sincerest thanks to Dr. E. J. Butler, Imperial Mycologist, through whose help and advice I was able to complete this investigation, and also to Mr. R. S. Hole, Imperial Forest Botanist, for arranging for such a good series of specimens.

[Plates 23 and 24 illustrate this article.—HON. ED.]

NOTES ON WORKS OF IMPROVEMENT IN THE F. M. S. FORESTS.

BY A. M. BURN-MURDOCH, CONSERVATOR OF FORESTS.

By "works of improvement," as discussed in this note, is meant any works carried out with a view to assist the natural regeneration of and the natural growth of the more important trees already growing in the forests.

The assistance which may be rendered to natural regeneration is here confined to scraping away the layer of leaves and mould on the ground, in some cases very thick, under parent trees, to expose the soil and allow of germination of the seed and the penetration of the young root to the soil. Seedlings of Chengal (*Balanocarpus maximus*) have been found in thousands under or near parent trees growing in a thick layer of leaves and leaf mould, and when examined later have been found to be nearly all dead, the theory being that the young root shoot has been unable to penetrate to the soil. In the case of some such seedlings sent me from Pahang, however, there was a fungus present, which attacked the young trees at the junction of root and stem.

Generally speaking, however, in these forests natural reproduction of the most important trees is good, and our chief aim should be to assist the young plants in every way in our power, chiefly by "improvement fellings." Roughly speaking, for purposes of works of improvement the forests may be divided into two main classes :—

1. What I will call the "Gutta-percha" forests.
2. Forests valuable for their timber trees.

In the former class, with which I will deal first, the forest is generally slightly less dense than in the latter, and the predominating important trees are *Palaquium gutta*, *oblongifolium*, and one or two other species of *Palaquium*. Here there is usually a marked absence of the most important hardwood trees. Fortunately there

is no mistaking the Gutta-percha tree, known to the Malays as Getah Taban Merah. It has rather stiff leaves, glossy dark green on the upper surface, and a golden brown colour on the under and can be recognised by any one.

Good instances of this forest are found in the Trollah Forest Reserve, Perak, in the Rantau Panjang Reserve, Selangor, and in many other tracts. These two classes of forest are not, of course, always distinct, and Gutta-percha is often found scattered throughout a good timber forest, but rarely in large numbers. It may safely be said, however, that in the former class of forest the chief aim of works of improvement is to assist the young Gutta-percha rees and seedlings. The assistance necessary to the few forest trees usually associated with Gutta-percha—*e.g.*, Tembusu (*Fagroea speciosa*, and *fragrans*), Merbau (*Afzelia retusa*, and *palambanica*), *should be effected if possible without prejudice to the Gutta*-percha.

In this class of forest the undergrowth consists very largely of Bertam palms (*Eugeissona tristis*), which grow in numerous clumps rising to a height of 20 or 30 feet, occupying considerable space and giving a dense shade. Both classes of forest are, of course, evergreen, with more or less dense undergrowth, and the occurrence of small areas of swampy land is very frequent. Here, of course, canes flourish in great abundance, but Gutta-percha and the best timber trees are usually situated in well-drained land and on hill slopes.

Bamboos are so few and scattered in most forests as to be negligible. There is also a host of small shrubs and poles of more or less unimportant evergreen trees, many of them belonging to the family "*Laurineæ.*"

The most noticeable characteristic of these forests is the vast quantity of trees per acre, as compared with ordinary Indian deciduous forests. The presence of a great number of tall trees in the pole stage is the result of a closely packed mass of seedlings of hundreds of species all struggling upwards, assisted by a moist tropical climate, with rain in each month in the year, and an atmosphere almost always saturated.

We have roughly three stories: first, the undergrowth of palms and evergreen shrubs, interfering with the establishment and growth of seedlings; second, a packed mass of tall poles; and thirdly the few giant trees, about 10 to the acre, which have succeeded in the struggle, and run to anything from 6 to 20 feet in girth and 150 to 210 feet in height. Besides these there is generally a fair amount of very tall trees of 4½ to 6 feet in girth and upwards of 100 feet high, which must be considered as in the third storey.

As to the treatment of the Gutta-percha forests, at first (from 1901 to 1907) the method adopted in Perak was to clear out all the small undergrowth on the area, working through blocks of varying size, and leaving the young Gutta-percha. This method had the advantage of being thorough, as far as seedlings and very small trees are concerned.

In Trollah Reserve, in some parts, as many as 50 per acre were found. The disadvantages are that it is expensive, as frequently patches of forest are thus opened up which contain little or no Gutta-percha.

This first operation cost about $6 an acre. The method now in force is to search systematically through the forest for seedlings and young trees and to free them individually. They often occur in groups. This first operation consists in clearing the young plants from undergrowth and in ringing and felling the trees overshadowing or interfering with the sapling trees.

A second operation is necessary after two or three years. This method costs under $2 per acre, in some places as little as $1 per acre or even less.

The work is carried out by a trained Malay mandor and a gang of Malay coolies, taught by, and under the periodical supervision of, a trained forest officer. This supervision should be very frequent, as Malays, if left to themselves, are very apt to clear too much undergrowth, and to do insufficient ringing of larger trees. Tall Gutta-percha saplings are often found 40 and 50 feet in height and only a few inches in circumference, and when freed cannot support their own weight, so dense is the forest that they

have been actually supported by the surrounding growth. These have frequently to be lopped off as high as possible, and always recover.

In commencing these operations, a forest officer of rank not below a first grade ranger should always be present for some time, until the staff of coolies thoroughly understand what is required of them, and inspection by senior officers must be frequent. We have now about 7,800 acres over which works of the above nature have taken place, and during the last eight years I have constantly inspected and found the results to be everything that could be desired; young poles of these species measured annually were found to have an annual average girth increment of over two inches, while in many of the larger trees of 20 inches girth the increase is as much as three inches annually. Good work has been done also in three small reserves in Pahang at small cost.

TIMBER FORESTS.

In this class of forest the valuable species with which we are chiefly concerned are as follows, in order of importance:—

1. Chengal, *Balanocarpus maximus.*
   ,, ,, *Wrayi.*
2. Merbau Bukit, *Afzelia retusa.*
   ,, Afzelia *palembanica.*
3. Tembusu, *Fagroea* (two species) *fragrans* and *speciosa.*
4. Penaga, *Mesua ferrea.*
5. Kulim, *Scodorocarpus Borneensis.*
6. Keranji, *Dialum laurinum.*
7. Kledang, *Artocarpus.*
8. Meranti, *Shorea* and *Hopea,* various species.
9. Jelutong, *Dyera costulata.*
10. Tampines, *Seoetia Sideroxylon.*
11. Resak, *Shorea barbata.*
   Balau, *Shorea materialis* (Ridley).

There are other good timber trees, but these may be considered the most important. Jelutong is important for its latex, which it yields in large quantities, producing a low grade rubber, it also

yields a soft white timber used for planking of ceilings and for native clogs. Chengal, Merbau, Resak, are hard and heavy, useful for sleepers and for buildings, bridges, as posts, beams, etc. Kledang, Penaga, Tembusu, make excellent posts. Tampines is useful for any purpose in which great strength is required. The Merantis of all kinds form the staple plank wood of the country. Most of these trees seed very freely, but the Dipterocarps do not flower annually. The work of assisting the seedlings and young trees of these species is exceedingly difficult, owing to the density of the undergrowth and consequent difficulty of finding them, and to the fact that they are difficult to identify. It requires long experience to be able to distinguish the young plants, and the average Malay is incapable of so doing.

A trained staff is therefore a *sine qua non*. The leaves of all young trees in this country are very much larger than in the older trees, so much so as to be quite unrecognisable except to the trained eye.

When it is considered that the plants to be assisted are buried in a dense mass of young growth, and that even in the pole stages they are difficult of recognition, some of the obstacles to this work may be surmised.

The results of letting in light judiciously to selected species are, however, proportionately satisfactory. So far very little has been done to assist the important timber trees, but a beginning has been made in Pahang, where about 1,500 acres have been treated, at a cost of about 60 cents per acre.

In the reserves treated, about 25,400 seedlings and young trees were freed from undergrowth interfering with them, and trees of useless species interfering with them ringed or felled. Of the trees assisted about half were Gutta-percha. Planting of Gutta-percha and hardwood trees has been undertaken for some years, but is costly. The young trees are planted in lines cut through the dense undergrowth, spacing half a chain apart and 12½ feet in the line. These lines have to be kept clear annually, and except in places where natural reproduction is poor and there are few or no parent trees, this method should be abandoned in favour of

works of improvement, supplemented by the planting out of seedlings in the spaces caused by the felling of large trees. It is too early as yet to say definitely what will be the results of improvement fellings in regard to timber trees, but as regards such works carried out in favour of Gutta-percha, which have now been going on for about seven years, there is no doubt. The results are eminently satisfactory.

The ringing of large trees suppressing superior species has been found to be better than felling, as the trees ringed die very slowly and light is let in gradually, besides which, felling is impossible without damage.

ORIGINAL ARTICLES.

DETERMINATION OF THE VOLUME OF AMORPHOUS PIECES OF WOOD.

INTRODUCTION.

The following method of determining the volume of amorphous pieces of wood without the aid of a xylometer is one which I evolved two or three years ago, while working out the specific gravities of certain wood specimens. The method is a simple and accurate one, and I have employed it frequently for finding volumes in camp, where it is inconvenient to carry about a xylometer. I have hunted the text-books to find mention of any such method, but can find none, so I presume it is new; I therefore give it in case it may be of use to others.

EXPLANATION OF THE METHOD.

The method is based on the laws of specific gravity. We know that the specific gravity of a piece of wood is the ratio which its weight bears to the weight of an equal volume of cold water, and since one cubic foot of cold water may be taken to weigh 1,000 oz. or $62\frac{1}{2}$ lbs., hence the specific gravity of a piece of wood may be found by dividing its weight in lbs. per cubic foot by $62\frac{1}{2}$.

Now if W be the weight of the wood, and V its volume, it weight in lbs. per cubic foot will be $\frac{W}{V}$, and its specific gravity will therefore be $\frac{W}{V \times 62\frac{1}{2}}$ (1).

Again, we know that the loss of weight in a body due to its immersion in water is equal to the weight of the same volume of water. Hence if we weigh the wood in air and again under water (suspending it by a string attached to one scale-pan of a balance or to a spring balance) we can find the specific gravity in the following manner :—

(*a*) *If the wood sinks.*

Let W = its weight in air

W^1 = ,, ,, under water

Then specific gravity $= \frac{W}{W - W^1}$ (2).

(*b*) *If the wood floats*, attach a sinker to it to make it sink.

Let W = weight of wood in air

W^1 = ,, *wood and sinker together* under water

S = ,, sinker *under water*.

Then specific gravity $= \frac{W}{W + S - W^1}$ (3).

Now to find the volume of the wood—

(*a*) *If the wood sinks.*

Combining formulæ (1) and (2) we have $\frac{W}{V \times 62\frac{1}{2}} = \frac{W}{W - W^1}$

i.e., $V \times 62\frac{1}{2} = W - W^1$

Hence $V = \frac{W - W^1}{62\frac{1}{2}}$ (4).

(*b*) *If the wood floats.*

Combining formulæ (1) and (3) we have $\frac{W}{V \times 62\frac{1}{2}} = \frac{W}{W + S - W^1}$

i.e., $V \times 62\frac{1}{2} = W + S - W^1$

Hence $V = \frac{W + S - W^1}{62\frac{1}{2}}$ (5).

APPLICATION OF THE METHOD.

The only apparatus necessary are a spring balance, a piece of string, and a sinker of lead or other heavy metal with a hook attached to it. The weight of the sinker *under water* should be found once for all. The size of the vessel of water in which the

weighing is done will depend on the size of the piece to be weighed. In camp a water-pail or zinc tub is generally available, and failing these the weighing may be done over the edge of a tank. The string is tied round the wood, which is then suspended from the spring balance and the weight noted. The wood, still suspended from the balance, is then lowered into the water, the sinker being hooked on if the wood will not sink without it. The weight of the wood, or wood and sinker, under water is then noted, and formula (4) or (5) above is applied according as the wood sinks or floats unaided.

R. S. TROUP.

17th August 1910.

ON THE SELECTION OF THE REPRESENTATIVE RADIUS.

In the August number of the *Indian Forester* (p. 455), "·OP" comes to the conclusion that the best way of obtaining the mean radius of a stump, for purposes of ring-countings, is to take half the arithmetic mean between the major and minor axes of the stump. His main objection to counting rings along a radius corresponding to the girth of the stump is that only one such radius, or at most two or three such radii, can be found, on none of which the rings may be clear enough to count. But surely the same objection holds with regard to half the arithmetic mean between the major and minor axes?

I consider the radius corresponding to the girth the more accurate of the two, because both in marking trees for felling and in measuring round timber we measure girths, not diameters. In counting rings along a radius corresponding to the girth we naturally assume that the girth of the tree throughout its life was represented along the same line of radius which need not necessarily be the case for each individual tree; it is, however, probably quite near the mark if a number of stumps are dealt with. Judging from my own experience, I think "·OP" rather exaggerates the difficulty of counting rings along a fixed average radius. This difficulty at all events falls to the ground by the employment of a special scale, whereby rings may be counted along *any* radius, the

measurements being automatically reduced on the scale to correspond to the average radius. A scale of this kind was first devised by Mr. Davis for use in preparing the Mawku working-plan of the Upper Chindwin Division, Upper Burma, and is described in that working-plan. Modifications of this scale are described on pages 25 and 26 of "The Practical Determination of the Girth Increment of Trees."

R. S. TROUP.

SHIKAR, TRAVEL, AND NATURAL HISTORY NOTES.

ANIMALS AND WATER.

BY LIEUTENANT-COLONEL R. G. BURTON.

I am glad to see that the subject of the drinking habits of wild animals has been raised in these columns by Dr. Lydekker. Either through the apathy or the absence of observers several points in connection with this question are still unsettled. I have at intervals during the past ten years discussed the matter in various publications, among others in the *Field* and the *Journal* of

the Bombay Natural History Society, but hitherto with very unsatisfactory results and without eliciting the desired information. As the readers of the *Indian Field* may not all have access to the above-mentioned publications, it may not be out of place to recapitulate here the points at issue, the evidence bearing upon them, and the information required towards their further elucidation.

My attention was first directed to the matter, apart from previous observations made when in pursuit of game, by the publication in 1901 of the first edition of Dr. Lydekker's book on the *Great and Small Game of India*. In this excellent work, to which we are so much indebted, as well as in the more recent edition in a modified form, we find it said with regard to the Indian antelope "whether it ever drinks is a matter on which there is a difference of opinion, but that it can exist without taking liquid seems demonstrated by the occurrence of a herd on a narrow spit of land between the Chilka Salt Lake in Orissa and the sea, where for thirty miles the only fresh water obtainable is derived from wells." Of the chinkara we are told, "it is believed by some observers never to drink, being often found during the hot seasons where there is no water except in deep wells. Even in places where water is found, Dr. Blanford states that he never saw the foot-prints of gazelles among those of animals that came to drink at the pools."

With regard to the Indian antelope I can say that I have seen them trooping down to the water to drink, that I have observed them in the act of drinking, and that I have in my possession a photograph of a herd at water taken in Rajputana and showing some of them in the act of drinking. In view of these facts I cannot believe that there exists among competent observers any "difference of opinion" as to whether the Indian antelope ever drinks.

As to the chinkara, Dr. Blanford's observations must have been faulty, or they must have been carried out in a part of the country where these animals had developed peculiar habits. I have seen a chinkara in the act of drinking; I have found them frequently in the vicinity of waterholes; and I have observed their tracks

leading to water-troughs placed for cattle in the vicinity of villages at a season of drought.

I take it as proved, then, that there can no longer be any doubt on these points, and that both the Indian antelope and the Indian gazelle are addicted to drink.

The second part of the question, whether these animals can exist for considerable periods without water, is still open. Dr. Lydekker appears to imply, from the Chilka Lake example, that they can and do exist entirely without water in certain localities. In his note on this matter in the *Indian Field* of 9th June he says:—"The question was discussed a couple of years ago at considerable length in the *Journal* of the Bombay Natural History Society by Major R. G. Burton who criticised the evidence as to animals in certain parts of India being unable to obtain water, and satisfied himself, if not his readers, that in some cases at any rate it is untrustworthy, and that if no other supply is available wild animals will often drink at the trough placed for the accommodation of their domesticated cousins."

Now it may be observed that I did not lay down the law in this matter, and that I did not and do not aver, that these animals cannot live without water in certain localities. But I called in question the evidence adduced on this point, considering it inconclusive, and at the end of the article referred to by Dr. Lydekker, I asked: "Are there in India waterless regions in which the species referred to (the antelope and gazelle) have become so adapted to their environment that they can live for long periods without water?" To that question I have hitherto received no reply, and I repeat it here in the hope that readers of the *Indian Field* may be able to throw light on the subject. Apparently I have been unable to convince Dr. Lydekker on the points mentioned in his most recent contribution, but I think all other readers will be convinced, firstly, that the evidence is untrustworthy; and, secondly, that wild animals will often drink at the troughs as described.

I know that scientific men generally require very conclusive evidence; yet I find that with regard to another matter, the

subspecific status of the Baluchistan gazelle, Dr. Lydekker is convinced on evidence which is no evidence at all—among other things the annulation of the horns of the female, a characteristic common to the Indian gazelle. This, however, is by the way. Let us return to our muttons.

The readers of the *Indian Field* may be interested to hear evidence on which Dr. Lydekker relies, and the grounds on which I have called that evidence in question. I must here reproduce much that was printed in my article on *The Drinking Habits of Wild Animals* in the *Journal* of the Bombay Natural History Society. In 1901, with reference to the Chilka Lake herd of antelope, I wrote in a contemporary: "More information is required with regard to this herd. Are there not troughs or irrigation channels from which the animals can obtain water?" Dr. Lydekker has since said that he believes the country in question to be perfectly barren and that the only fresh water obtainable is derived from wells. But if the country is barren, what are the wells for? And if there are wells, there are probably troughs for animals to drink at, or irrigation channels to water some crops—even in a generally barren country. My query in 1901 elicited the following from a gentleman who wrote under the pseudonym of "The Judge": "A discussion being now on foot whether antelope can exist without water, a few notes are subjoined, especially regarding those of the tribe that haunt the foreshores of the Chilka Lake. As one of your correspondents lately pointed out, it should be specially established that the antelope in this supposedly dry and sandy tract cannot have access to any supply save springs and wells. I may premise that I am among those who think that it is highly improbable that antelope can exist without this liquid, about in fact as improbable as the old Scotch minister in his pulpit thought it was that a camel could go through the eye of a needle. We know better now, thanks to modern science, for the camel in the early stages of his existence is like the human at a similar time, almost indistinguishable by the eye without a microscope.

"It is twenty-one years since I first grassed a black buck, and natives assure me they drink regularly. As to the special tract

from which I write, they have an ample supply of fresh water whenever there is rain about, that is from early April when showers fall in these parts up to November when they cease. I visited this morning the south-eastern shores of the Chilka Lake [the date of this letter is unfortunately not known to me.—R. G. B.], and on the plain found many of the antelope tracks, but had no time to follow them up; a native with me saw the herd two or three days back. This locality is at the extreme south of Bengal, latitude 19·30 N. and longitude 85·15. Everywhere in the plain are hollows where water is now and constantly standing during several months of the year; there are also pools among the sand-hills close to the sea, which the Telugu people call 'Dibbula,' and these are common all down the coast. Besides these sources of supply there are also paddy-fields having water now in them and a flourishing crop on them.* The ordnance survey map shows the land now occupied by them to have been once a mere swamp. No doubt the struggle for existence has caused them to be reclaimed and cultivated. Thus the antelope of these parts have plenty of water for the present; they are no doubt cousins or descendants of the herds which are or were common about Puri, 50 miles north up the coast, and there is nothing to prevent their migrating there periodically. In 1840, as recorded by the then Chaplain of Cuttack, the natives used to spread a net across the strip where it was narrow enough for the purpose, and drive them into it. The strip is now too wide for this plan; however, still it remains to be seen whether there is a water-supply for them in the hot weather. Here one may note 'hot' is a comparative term. Owing to the hills on the shore side and the trend of the coast, hot winds are unknown, the breeze is always a sea-breeze, moist and cool, and the thermometer is rarely above 90° in the shade.

"But why should not antelope swim across to the mainland for a drink as undoubtedly do the spotted deer that live on the Chilka islands? In the hot weather the water of the south of the lake is moved up to the north by the strong south winds, and Sir

* *N.B.* Is this the part of the country believed by Dr. Lydekker to be perfectly barren?

W. W. Hunter records in his *Orissa* that the level of the lake is at the north many inches higher than it is at the south owing to this continuous pressure of air on it. Something similar about the upper end of the Red Sea in earlier times no doubt did for Pharaoh and all his hosts. I do not know that antelopes swim, but possibly they may and can do so under pressure from thirst and otherwise. Leander swam the Hellespont with no other thirst but that for the dewy lips of his Hero, and one might back a black buck against Leander. At all events, the antelope at the southern end of the Chilka Lake could easily obtain fresh water by going southwards over the Presidency boundary where the Lake ends and they would find it beyond their strip, for here there are hills holding bears, wild pig, and panther."

If "The Judge" has not left India or gone to the Happy Hunting Grounds, perhaps he will furnish us with some more information regarding this interesting region. Or possibly some other resident in that part of the country, or "Raoul," who has lately been writing about it in these columns, can throw some light on the point at issue.

Another letter on the subject was written by a most competent observer, G. S. R., who said :—"I made special enquiries during a recent visit to Bikanir and Jodhpur, where the heat in the hot weather is terrific, and antelope with gazelle exist in numbers, and where in the former State water is only obtainable from deep wells, and in most parts also of the latter country. I was informed by several persons, European and native officials, that during the hot season, when all the tanks are dried up, herds of antelope and gazelle regularly attend the cattle-drinking troughs in the evenings. In several parts of Jodhpur many persons are kind enough to fill troughs in the jungle away from villages for the benefit of antelope just as kind people at home feed wild birds during hard winters. In addition to obtaining this supply of water, antelope and gazelle eat largely of the flowers of the *Ak*, which no doubt contain moisture. Antelope maddened by thirst have been known to jump down village wells. That antelope with the help of eating flowers, etc., can exist for several days without water, seems to be generally

held, but not for a longer period than a week during great heat, after that time they die."

I have certainly convinced myself, and I think that sufficient has been said to convince my readers with the possible exception of Dr. Lydekker, that antelope and gazelle do drink; that they sometimes drink from troughs; and that the evidence advanced by that distinguished authority on natural history to the effect that there are places in India where these animals exist without water is at least inconclusive. I do not aver that there are no such localities, but more evidence is required before this can be taken as an accepted fact. No doubt wild animals can exist for a time without water just as human beings can, and as Dr. Tanner, an "exhibit" at the Royal Aquarium many years ago, continued to live for forty days without food. But that is a very different matter. And I repeat, are there in India waterless regions in which the species referred to have become so adapted to their environment that they can live for long periods without water?

May I quote the poet whom I have quoted so often, and still hope that, in spite of our naturalist—

> The wild gazelle on Judah's hills
> Exulting yet may bound;
> And drink from all the sacred rills
> That gush on holy ground.

And may I relate once more how in a season of great drought I was encamped at a place where the only water was contained in the wells and irrigation channels in the vicinity of villages. At these wells the patient, laborious cattle toiled all day to draw the water that ran down the channels to irrigate the fields. At night when all was quiet and the watchmen slumbered on their platforms amid the crops, the *nilgai* always came down and drank where the water had collected, and especially at the wooden troughs, hollowed out of the trunks of trees, which were placed for the cattle near the wells. The marks of their feet might be plainly seen in the soft mud every morning. At night, too, the prowling panther visited such spots, where he might find a victim among the herds of gazelle that trooped down during the hours of darkness from the neighbouring stony and arid hills, or might pick up a stray goat,

or dog, or calf belonging to the hamlet. The gazelles drank here in numbers, leaving a beaten pathway from their jungle haunts.

Around the life-giving water all that passes during the night, all the comings and goings of the beasts of the field may be read from the book of nature which lies open to the observant eye. There is the beaten track of many dainty little pointed feet, the marks of the gazelle, and the larger spoor of the antelope. The pugs of the panther may be looked for upon any of the dusty paths that approach the troughs or water-channels. All animals prefer to keep a beaten track, and their wanderings are thus more easily followed. The porcupines, most nocturnal of creatures, have come down from their cave-dwellings in the banks of the dry ravines and in the hillsides, and one has dropped a quill beside the trough, while another has pierced through the heart a goat that was tied up as bait for a panther in the adjacent nullah. Jackals, wild cats, foxes, hares, peafowl, partridges, quail—all these have passed to and fro at the setting of the sun or in the silent watches of the night, and have left unmistakeable and sometimes unsavoury impress of their presence where they have been to quench their thirst.

I have found no wild animals that have died of thirst, but in the famine time human beings may be less fortunate than the beasts of the fields. I saw one morning the skeleton of a man who had died during the night, picked clean by foul beasts and lying grim and ghastly in the light of the rising sun. A small pool of water lay in an adjacent channel, towards which the bony arms were stretched as though in mute appeals. A wretched rag that had formed the clothing of this "image of God" lay beside the sad remains. The wayfarer's staff was lying near. Perhaps his tottering steps had failed at the margin of the water, for which he was making. Who can tell ? There he had gasped out his life. The eyes that once glowed in those now empty sockets had been plucked forth by vultures. The heart that once beat beneath those gleaming ribs had been torn out and rent by jackals which had stolen away from the scene of the tragedy at the dawn of day. That night the jackals may have required no such thin stuff as water with which to quench their thirst !—(*Indian Field.*)

THE CLIMBING POWERS OF THE TAHR.

So far as my experience goes, the climbing powers of the Himalayan tahr are unsurpassed by those of any other wild goat, and it is doubtful whether even the markhor is quite so much at home on precipices, where the slightest slip or miscalculation of distance would almost certainly mean a fall of hundreds or even of thousands of feet. I have frequently seen tahr climbing with ease along the faces of almost perpendicular cliffs in a manner that made one break into a cold sweat to watch, and when suddenly alarmed they will jump or scramble down crags and ledges that one would have imagined no creature not possessed of wings would attempt to negotiate.

The most remarkable instance of their extraordinary powers in this respect that I have seen was furnished by a fine old tahr which I shot not very long ago. I left my camp very early one beautiful May morning, accompanied by two of the local shikaris, who were old friends of mine, and about an hour after we started we reached a ridge, falling away on its far side into a deep ravine beyond which rose an almost perpendicular wall of rock fully 1,500 ft. in height. We peered very cautiously over the ridge, and at once spotted several tahr feeding among the few rhododendron and other bushes that clung to the face of the wall of rock opposite. Most of them were young males not worth powder and shot, so far as we could see in the deep shadow which still overhung the cliff; but there were two fine-lookng black fellows feeding rather apart from the rest, and not more than 150 yards from us in a direct line, and a little above our level, and a glance through the binoculars showed me that both had fine horns. I therefore drew a careful bead on the nearer of the two and pressed the trigger. The one I had fired at seemed to spring downwards and disappear as if by magic, while the rest rushed upwards towards the right, running along narrow edges and clambering up what looked like almost perpendicular walls of rock like so many ants. The second black fellow led the way, but by the time I had ceased wondering what had become of the first he was over 200 yards away, and a couple of running shots failed to touch him. So I let

them all go, and within a very few minutes they had reached the top of the cliff and disappeared from view.

Still puzzled as to what had become of the first one I had fired at, I took up my binoculars again, and then discovered that just below where he had been standing there was a sort of cleft in the rock, though I could not see how deep it was or in which direction it ran. One of the shikaris, however, after staring at the spot attentively for some time, vowed that he could see a rhododendron bush that projected into the cleft shaking slightly, and that the tahr must be hiding behind it. I could see nothing even with the glasses, so we decided that I should stay where I was while the two shikaris tried to find a way round the head of the ravine and along the face of the cliff, so as to drive the tahr out in front of me. In about a quarter of an hour they appeared, creeping along the cliff and hanging on to rocks and bushes. I sat all ready for an awkward running shot, but nothing came out, and the moment they reached the cleft they shouted out that the tahr was dead and hanging to the rhododendron bush by his horns. Luckily, they had some stout rope with them, and, tying him up with this, between them they managed, with great difficulty and very considerable risk, to lower him down, and eventually to bring him along to the head of the ravine. He had a good pair of horns and a fine long coat and flowing mane unusually dark in colour, but the remarkable thing about him was that he had, for all intents and purposes, only three legs. Probably through an accident, caused by a slip or fall of rock some months before, the bone of one hind leg was broken right through a little above the fetlock, and the broken end with the foot attached to it hung by a mere strip of callous skin and tendon. The wound was completely healed up, and the tahr, though a little thin, was in a perfectly healthy condition. The broken leg must have been absolutely useless to him, and yet it was evident that, in spite of this fact, he had found no difficulty in keeping with the herd, and was still quite at home on any sort of ground. When the rest of the herd bolted up the cliff they obviously followed a pathway that they were well accustomed to, and no doubt if my bullet

had not stopped him he would have gone off the same way pretty nearly as fast as his companions.

My bullet had taken him fairly behind the shoulder without actually penetrating the heart, and the shaking of the rhododendron bush had been caused by his dying struggles. If by great good luck his horns had not caught in a branch he would have fallen headlong several hundred feet, and in all probability would have been smashed to pieces.—(*By C. S. in the Field.*)

THREE WILD DOGS AND A HYÆNA.

In a matting enclosure behind a broken down deserted mud-hut, a quarter of a mile from a tiny village nestling in the jungle-clad hills of the Central Provinces, 100 miles from any railway, I sat one bright moonlight night, keeping silent watch. The object of my vigil was a well-known and much-feared panther, which had terrorised the village for the past two years. Alas! he was not destined to fall to my gun. A goat stood picketed as bait, thirty yards away. A loophole in the matting enabled me to see all the approaches. Hour after hour I sat straining my eyes and ears to detect the slinking form or soft tread of the coveted marauder. As the deep shadow of the trees began to draw in and the tiresome village dogs wearied of their incessant howling and barking, I heard a faint sound, like somebody amusing himself cracking his finger joints, in the distance, which, slight as it was, put me all on the *qui vive* and tightened the grasp on the rifle by my side. There was no mistaking its origin as it drew nearer; and as I expected a hyæna presently emerged from the jungle and paused an instant in shadow. Seeing the goat, he slouched up within ten yards, cracking his toe joints and uttering a peculiar low moaning sound, and stopped once more. The goat on seeing him began to snort in an agony of terror, realizing its danger. I still had a lingering hope that the panther would turn up, although he invariably committed his atrocities earlier in the evening, so when the hyæna plucked up courage and approached nearer to the goat, I only hunted him off. I can see him as I write; one couldn't

help remarking the intensely ugly appearance of the beast, with his large round head crowned with two enormous ears; his great jaws; his striped body tapering down behind to an angle of 45 degrees to the ground. And not merely outwardly ugly, but as I knew from experience the possessor of a black heart. An arrant coward, a scavenger of the worst order and a monster for cruelty. And now that I have relieved myself of these anathemas against an animal which, however, richly deserves them, I will continue my narrative. My charges, although not demonstrated in this particular article, are perfectly justifiable. Well, an hour after he had been hunted off, he turned up again, and once more stood at a safe distance, endeavouring to work himself up for an assault on the goat. He half succeeded at last, and made a faint-hearted rush, which was bravely repulsed by the goat, head down.

Defeated, he clicked off again, with his tail between his legs, only to re-appear five minutes later, apparently meaning real mischief this time. Without waiting to let his courage slip away, he made a bold dash for the goat, which, however, determined to sell its life dearly. The hyæna was butted back a few paces, but came in again and succeeded in knocking the goat over. I couldn't resist any longer, but sent the brute howling to kingdom come with a charge of slugs. I had no fancy for being present at the orgies of this truly loathsome creature, which, had I reserved my fire, would have torn a mouthful out of its wretched victim, without troubling to kill it, and continued his meal while the poor thing lay there struggling, conscious all the while that it was being devoured piecemeal.

Leaving his carcase to the tender mercies of his prowling brethren, I untethered the goat, and drove him back to camp.

The next evening saw me on watch as before over the same goat. The previous night's disappointments with regard to the panther were all forgotten, and hope reigned supreme. But the panther's luck held good.

About the same time as the hyæna had appeared the night before, I heard a terrific crunching of bones not a hundred yards away and made up my mind that it was the panther, and awaited

developments accordingly. Half an hour later, while the crunching was still going on, a pair of, as I thought, village dogs turned up and began teazing the goat, much to my annoyance. These were joined in a few minutes by four more, and as I looked presently, there was a surging snarling mass of dogs round the much-bewildered goat. At last I grasped the fact that these were no ordinary village dogs, but the cunning Indian wild dog or Dhol, which are a source of terror even to the lordly tiger. There was no mistaking those bushy tails. Once more I was forced to give up my hopes of the panther and save my poor goat. Two barrels of slugs into the crowd had a magic effect. The scene was cleared in an instant; the pack had vanished, but minus three of its original number. The goat quietly dropped on his knees, resumed his sitting position and continued munching leaves quite unconcernedly. I finished my vigil in the grey dawn, but nothing further happened that night.—(*By Cordite in the Indian Field.*)

ANOTHER HUGE MAHSEER.

On September 20th, a friend and I went to the Hutty and Cauverie rivers for a four days' fishing excursion. We found the river a bit big, but clear. The first day on the Hutty my friend moved one fish. The second day we fished the Hutty to its junction with the Cauverie, and then went on into the Cauverie. A little before 3 P.M., in the second run in the Cauverie, when I had given up all hope of moving a fish, and at the end of the run, as I was making my last cast, I got a tug at my line that fairly astonished me. The fish, at once went upstream for about forty yards, then turned and came down at a frightful pace, passing me in my coracle about thirty yards away, and taking out about eighty yards of line before he stopped. He then made across the river, and then upstream again, and got under a rock. I got up above him, and then dropped downstream to the rock, reeling up as I went. When I was within twenty-five yards he came out and went downstream once more. I then made for the middle of the pool (which had a good current on it), and signalled to my friend, who was below me, to come up. This he did after some trouble, as the

current was against him. I tried to keep the fish in mid-stream as well as I could, but he insisted on making runs all over the pool. After about an hour of this I got him fairly close to the coracle, and he kept going round and round me, while I put on all the pressure I thought my rod and tackle would stand. This went on for over thirty minutes, but, do what I could, he would not come to the surface. When at last he did come up a little, and I got a glimpse of him, I worked away and managed to get his tail up, but he kept his head very low in the water. After two hours at him I found it was no go; I should never get him up, his weight was too much. So I made up my mind to get him to the side of the pool and try to shelve him. It was an awkward job, as the bank was difficult, with trees and roots around some nasty bushes below, and only one small clear space of about fifteen yards. However, I managed to get him there, and my friend followed in his coracle. We both stranded our coracles, my friend's below mine, and I succeeded in getting the fish up close to his coracle; in fact, more than half the fish was under it when he gaffed him. Then, with the help of our two boatmen, we dragged him on to the bank, and could see what a beauty he was; I began to think I had broken my record of September 1906, when I killed a fish of 104lb. But when we weighed him we found that he scaled 103lb. We then got the tape, and measured him, and found his dimensions as follows: Length, 64in.; girth, 39in.; mouth across, 8½in.; tail across, 19in. The dimensions were very much the same as those of my record fish, which was 104lb.; length, 66in.; girth, 37in.; mouth and tail the same, *i.e.*, 8½in. and 19in.

I was using a 16ft. Hardy's Hi Regan salmon rod, cane built, steel centred (the second joint had a nasty bend in it just above the joint after the fight, but I am glad to say it is now straight again), a No. 8 spoon mounted by myself with a swivel and one treble hook, a Punjab wire trace (also made by myself), a Hardy's silex reel, and a tanned flax line.

C. E. MURRAY-AYNSLEY.

[Readers of the *Field* will remember Mr. Murray-Aynsley's account of his other great fight with the 104-pounder, which appeared in the issue of November 10th, 1906.—ED.]

(*Field.*)

EXTRACTS FROM OFFICIAL PAPERS.

RUBBER PLANTATIONS.

PROPOSED EXPERIMENTS BY THE BOMBAY GOVERNMENT.

Reporting upon the rubber plantation scheme started by the Bombay Government at the instigation of the Chamber of Commerce, Mr. Proudlock, Curator of the Government Botanic Gardens and Parks in the Nilgiris, says:—I propose for consideration that land be granted to the prospective rubber planters on the following terms:—

(1) That the Government will fell and remove all timber it may decide to fell and remove from land before handing it over to the grantee.

(2) That the grantee shall be free to dispose of, as he thinks fit, any timber that may be on the land after it has been made over to him.

(3) That the grantee shall pledge himself not to burn felled jungle and brushwood (except thorny species) on land granted to him.

(4) That rubber shall be the principal crop to be grown.

(5) That the minimum number of rubber trees shall not be less than 50 to the acre.

(6) That no rubber trees shall be cut down that will have the effect of leaving fewer than 50 evenly planted trees to the acre except with the sanction of Government or its authorised agents.

(7) That the grantee shall, after having to the satisfaction of the Government planted land with rubber trees, have full liberty to grow suitable catch crops on land between the rubber trees. It should, however, be understood that these must be considered to be of secondary importance to that of rubber trees, and their cultivation must be discontinued when it is detrimental to the rubber plants.

(8) That Government will in all cases, as far as may be convenient, practicable or advisable, grant permission or facilities to

the grantee to obtain a supply of water from streams or other sources beyond the boundaries of the land granted to him for the use of his plantation.

(9) That land shall be granted free of assessment, but in lieu of assessment a royalty or export duty of four annas per pound shall be paid by the grantee to the Government on every pound of rubber that is obtained from the rubber trees used, manufactured or sold on his plantation or exported.

(10) That all rubber plantations, factories, stores, sheds and buildings of any kind whatsoever shall be open to inspection by duly authorised Government officers at any time.

(11) That any evasion, neglect to carry out, or contravention of the aforesaid conditions shall be dealt with by Government as the circumstances of each case may warrant.

He further recommends Kanara as the district in which it is most likely to grow rubber profitably.

The Government have issued the following resolution on the subject :—The criticism to which Mr. Proudlock's conclusions have been subjected by the Conservator, Southern Circle, point to the conclusion that rubber-planting in Kanara is not likely to be successful financially. It has, however, been represented to Government that the plantations at Gairsoppa have never been given a fair chance, and that, therefore, the experiments hitherto made there do not give a proper indication of the probabilities of the success or otherwise of rubber growing in Kanara. Climatic conditions are unfavourably compared with those prevailing in other rubber-producing countries, but with proper care and at considerable expenditure on account of watering, the difficulties might to a certain extent have been overcome. In the circumstances the Governor-in-Council has come to the conclusion, that the best thing to do now is to select ten acres out of land already cleared and partly planted up at Gairsoppa, plant it carefully with para, water the plants until they become independent and spare no pains to ensure success. The requisite action should be taken by the Conservator. In the remaining area plants should be left to take their chance and no further expenditure should be incurred on

their account. At Kadra, no further expenditure should be incurred beyond what may be necessary for the maintenance of the fence and for occasional weeding of the plantation area. It is understood that Mr. Copleston considers that para will thrive in many of the more or less open spaces along Kanara ghats. He should be encouraged to experiment on a small scale. With respect to plantations in the Northern Circle all officers are agreed that the conditions there are less suitable than in Kanara. The Governor-in-Council, therefore, is pleased to direct that the existing plantations should be maintained, but that no further extension should be encouraged until Government receive further assurances of the probabilities of success. It appears that the area of land suitable for growing para is small and scattered, and Government do not feel justified in inviting applications from the public. If any private individual desires to inspect the country and to select an area which on the information available to him he deems to be suitable for para plantation, every facility will be afforded to him, and local forest officers will be instructed to place at his disposal all information at their command. Government do not consider it necessary to take any action on the suggestion from the Conservator of Forests, Northern Circle, for the planting of *Ficus elastica* along the roadsides. Climatic conditions are not very favourable to its growth, and it is hardly conceivable that any appreciable revenue would be realised from rubber trees growing on the roadside.—(*Pioneer.*)

DRY ROT IN TIMBER.

(MERULIUS LACRYMANS, FRIES.)

We give below the text of a circular issued by the Department of Agriculture on the above subject :—

As a destroyer of timber used in the construction of dwelling-houses, the fungus popularly known as "dry rot" has been well known for many years. Notwithstanding modern improvements in ventilation, etc., the disease appears to be gradually gaining ground. This is chiefly owing to the following causes: (1) the use of immature and imperfectly seasoned wood; and (2) the rapidity with which modern houses are built, resulting in the imprisonment of a superabundance of moisture in the material used.

Infection with the dry rot fungus sometimes takes place in the forest, when felled timber remains stored there for some time. The first evidence of such infection is indicated by the presence of red stripes in the sawn wood. If such wood be thoroughly seasoned the mycelium present in the red stripes is killed. If the seasoning be neglected, or imperfectly done, the mycelium which possesses the power of remaining in a latent condition for some time, commences active growth when the wood is used in any part of a building where it is exposed to dampness and this in some cases is unavoidable, as when the ends of joists are built into a wall.

Under such circumstances dry rot eventually appears.

On the other hand, the fungus is by no means rare on old beams and boards stored in wood-yards, etc., and it is mainly from such sources that spores, or portions of the spreading mycelium, are introduced into buildings by new wood which has become infected.

Again, when a house that has suffered from dry rot is being repaired, sufficient care is not exercised in the immediate destruction by burning of all diseased wood; and portions that are not too much decayed are often stored for repairing purposes. In consequence the air in towns always contains spores of the dry rot fungus.

During the building of a house the danger arising from the presence of dry rot may be reduced to a minimum by taking, proper precautions.

A thorough system of ventilation and the avoidance of damp, stuffy places is of primary importance. The endeavour to exclude dry rot by hermetically closing all communication with the outer air in the spaces between flooring-boards and joists, and similar places, has been practically demonstrated to be an utter failure. In the case of a recently constructed mansion the expenditure of many thousands of pounds was entailed in rectifying the consequences of such a proceeding.

Perhaps the greatest source of danger arises where the ends of joists are built into a wall near the basement of a house, and this is more especially true where there is evidence of red stripe in the wood. As a precaution, the ends of joists should always be treated with creosote. Coal tar is not recommended, as its power of penetrating into the wood is very limited, and by forming a waterproof coating it prevents the wood from drying.

A frequent cause of trouble is the use of damp deadening material, or "pugging," and covering it over with boards before all the moisture has evaporated. Such material should be used as dry as possible, coarse sand being the best for the purpose. The surface of boards coming in contact with deadening material should first be painted over with methylated spirit containing corrosive sublimate in solution—six ounces to one gallon. The spirit evaporates, leaving a coating of corrosive sublimate on the boards, which completely destroys any mycelium coming in contact with it.

It has been proved that the spores of dry rot can only germinate in moisture containing some alkali in solution, hence coal-dust cinders, or any kind of humus should never be used for deadening or packing.

The fruit of the dry rot fungus presents the appearance of irregularly shaped, flattened or undulating patches of variable size, adhering by their entire under surface to the substance on which they are growing. When mature the central portion of the patch is covered with an irregular network formed by slightly raised

anastomosing ribs, and is of a rich brown colour, due to the enormous quantity of spores, which are deposited on surrounding objects under the form of snuff-coloured powder. These spores are diffused by currents of air, or by rats, mice, and insects.

The margin of the fruiting patch is surrounded by a snow-white fringe of mycelium, which spreads in every direction over surrounding objects, creeping up walls and passing through crevices, the advancing mycelium being supplied with food and moisture from the parent plant growing on wood.

This food is conducted through cord-like strands which form behind the thin advancing margin of mycelium.

Owing to this supply of food from a central source, the mycelium can extend over stones and other substances not containing food, and thus spread from the basement to the top of a house. Each time the migrating mycelium comes in contact with wood, the latter is attacked, and a new centre of food-supply is established from which strands spread in search of other sources of food. The mycelium often forms felt-like sheets of large size that can readily be removed intact. These sheets are white at first, but soon change to a pale grey colour, a character by which dry rot can be readily distinguished from another wood-destroying fungus, *Polyporus fomentarius*, even in the absence of fruit, the felted mycelium of the latter remaining permanently white.

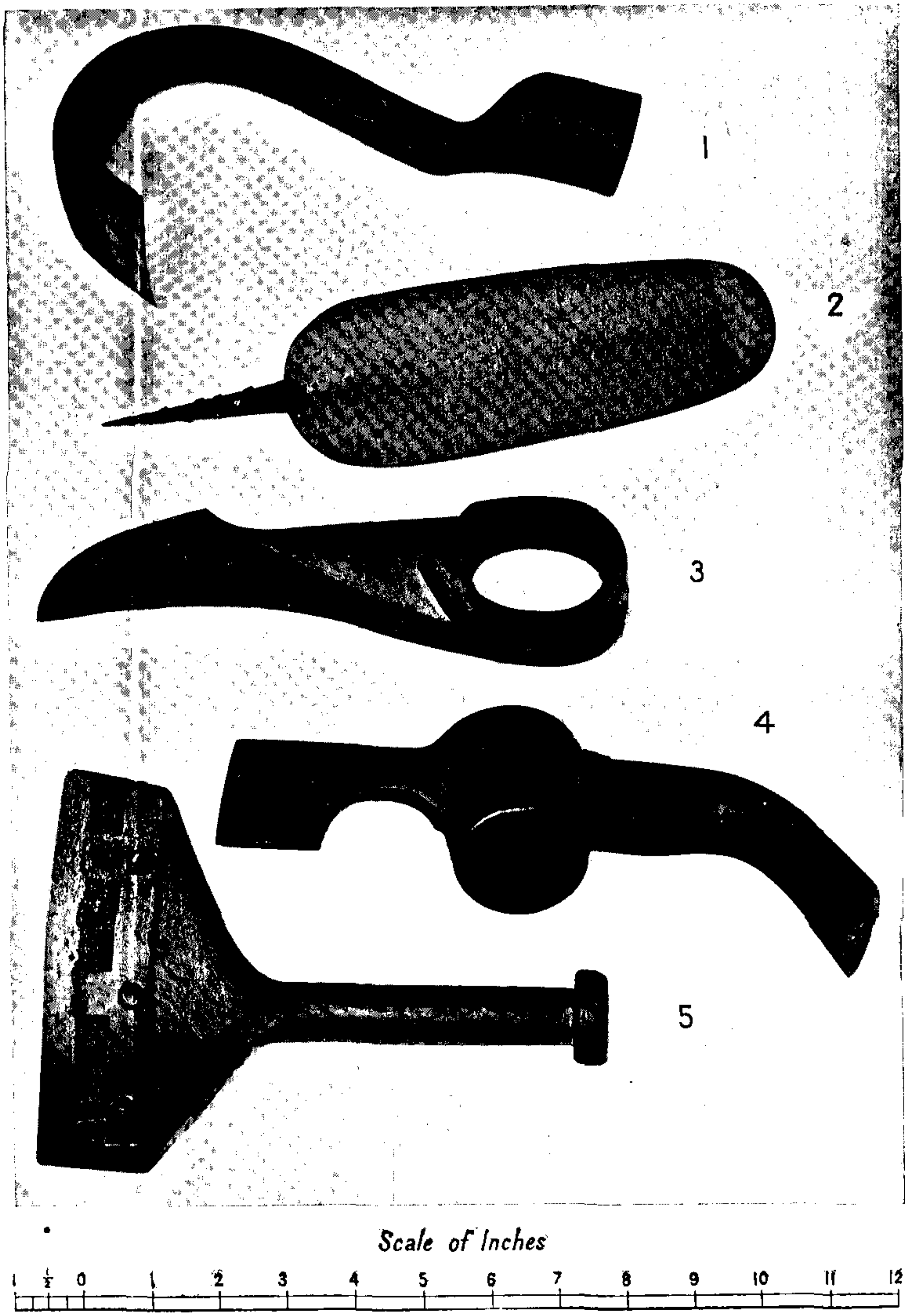
The spreading mycelium can be checked by the application of carbolic acid, and when its presence is once detected, all woodwork that can be reached should be thoroughly saturated with the same substance.—(*Timber Trades Journal.*)

"GUAYULE RUBBER." *

The production of rubber from the Guayule shrub (*Parthenium argentatum*) is of particular interest, because the problems involved are more intricate than those dealing with the production of rubber from ordinary latex-bearing plants, and also because Guayule is

* Extract from a paper read before the London Section of the Society of Chemical Industry by Philip Schivrowitz.

produced on a very large scale, the amount manufactured during the past year being estimated at, roughly, 4,000 tons. The Guayule shrub, which prefers an altitude of 4,000 to 5,000 feet, is distributed unevenly in a belt of territory from one to a hundred miles in breadth extending roughly from Fort Stockton in Texas to the Tropic of Cancer in Mexico. In this shrub rubber occurs in solid particles dispersed through the mass of the woody fibre. According to Mr. M. P. Fox the wood contains from 6 to 18 per cent of rubber, a similar quantity of resin, and about 10 [per cent of extractive. Two processes are employed to separate the rubber from the wood, one consisting in extracting the rubber by means of solvents, and the other, which consists in disintegrating the woody mass in such a manner as to separate the rubber; a combination of the two processes is also employed. Two main grades of Guayules are prepared, one containing about 30 per cent of resin, and the other, from which part of the latter has been extracted, containing about 3 per cent of this impurity. Since the extraction of rubber involves the destruction of the shrub, it is estimated that within four years from now practically the whole of the standing shrubs will have been destroyed. For the period 1906 to 1909 some 17,000 tons of rubber were prepared from Guayule which corresponds on a 7 per cent basis (for wood containing 25 per cent of water) to roughly 328,000 tons of shrubs.



SOME FRENCH RESIN TAPPING TOOLS.

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TRANSPORT OF FOREST PRODUCE.

The necessity of having up to date means of transport for forest produce is obvious to those who consider the matter. The comparative bulkiness of such produce is such that it seldom pays to export it from points far from the railway.

For every kind of produce and for each locality there is a maximum lead or economic radius beyond which it does not pay to export. All produce situated further off than this is comparatively valueless. In order to make the most of the yield of our forests, it is essential that we should always be striving to improve and cheapen our methods and means of transport, and thus increase the distance up to which it pays to export our products.

Cheapness is not the only advantage of proper mechanical means of transport, for quite as important an advantage is the certainty that a given quantity of produce can be regularly delivered. It may happen that export by local means is possible at a remunerative rate under favourable circumstances, but there is always the question as to whether a given supply can be exported in a fixed time, for the local means of transport may fail from

various causes, such as cattle-disease or famine, or the rate may increase beyond the profitable limit. A capitalist under such circumstances is shy of embarking on new enterprises in face of such risks, whereas if a properly designed mechanical means of transport existed the uncertainty would be removed.

In our issue for May 1909 we drew attention to the importance of forest engineering, as it is in particular this branch of knowledge which enables us to improve the means of transport and to evolve new schemes and methods, in order to lessen the cost of extraction. We advocated in the article referred to the appointment of a special officer for this work, so that he could devote the whole of his time to the subject. The question was considered by the Board of Forestry in March last, and it was agreed that the services of an expert forest engineer would be extremely useful in many cases, and it recommended that an expert engineer should be appointed on the Research Institute cadre. We trust that this proposal will be sanctioned in due course. It is obvious, however, that all such transport schemes for the whole of India cannot be originated by a single officer, and it is extremely necessary that local officers should first think out and evolve possible schemes for consideration by the specialist whose duty would no doubt be to report and advise on all proposals regarding such schemes. We consider it is essential that the officers of the department should be encouraged to increase their knowledge as to the most up-to-date methods of transport in order that they may evolve suitable schemes for consideration. At present the facilities for acquiring this kind of knowledge are not great. Officers on leave, may by taking study leave under the rules in appendix XIV of the code proceed to the continent to improve their knowledge of forest works there, but no encouragement is given to officers to study elsewhere We especially refer to Canada and the United States, where all kinds of modern methods of transport are employed. We feel sure that the study of this subject in these countries would be of great use in developing the forests of the Indian Empire by enabling officers to evolve suitable schemes for facilitating and cheapening of transport, and

we trust that the present rules regarding study leave on the continent may be extended so as to apply also to Canada and the United States where in addition to transport works there are now so many instructive forest operations to be seen.

SCIENTIFIC PAPERS.

A SHORT DESCRIPTION OF THE STATE PINE FORESTS OF THE LANDES AND GIRONDE DEPARTMENTS.

The parts of the Departments of Gironde and Landes which lie between the river Garonne and Dax and Bayonne hold a very large proportion of forest. Along the coast stretch sand dunes for an unbroken length of 225 km. (= 140 miles). The average width of these coastal dunes is some 5 km. (3 miles). The soil at least anywhere near the coast is *pure sand*. Inside the dunes there is a strong pan near the surface. The climate is rather hot with mild winter. The rainfall is 32".

Formerly the coastal dunes were devoid of tree growth, and with the strong west winds from the Bay of Biscay they advanced steadily inland at a rate up to 20 metres a year. The greatest height they attained was 80 m. The 14th century church at Mimizan Bourg is now partially buried by sand though it is about three miles inland.

The whole area of these dunes is 100,000 hectares (250,000 acres) of which 80,000 have now been converted into forest. Of this area 50,000 hectares are State forest and 30,000 have been sold or belonged originally to Communes or private persons. The work on the dunes was commenced in 1787. The greatest of the workers was Bremontier. The operations were considered finished in 1864. In all 13,000,000 frs. have been spent.

The marshes formed behind the dunes are called "lettes." These are now drained and often owned privately. For purposes of description of the work done the area may be divided into the artificial littoral dunes and the remainder :

1. *The littoral dune.*

The formation of an artificial littoral dune close to the sea to a height of 10 metres and the planting of the pine over the whole area inside the latter have stopped the moving of the sand and converted the whole into stable and valuable land.

The principle of forming an artificial dune is simply to raise obstacles against which the sand may be blown by the wind and be heaped up. The obstacles may be planking, branches, wattle-work, grass, etc.

The obstacles are created and again wholly or partially removed according as the sand is required to be heaped up or partially or wholly moved on or blown away by the wind. The ease with which the wind moves the round particles of sand, and the difference which a little grass (*Psamma arenaria*) more or less makes, have to be seen to be believed.

The standard shape of the littoral dune has been changed in the last 30 years. The old idea was to let the sea erode and build again. The old method of using vertical planks 3 cm. (1·2") apart to let the sand drift through) in building the dune is obsolete. On the private dune at Mimizan we saw as obstacles besides the clayonnage (cordons tressés), cordons simples (fences of upright branches without interlacing) and bouguetage (bundles of faggots stuck vertically in the ground at close intervals). Gourbet (*P. arenaria*) is planted between.

In the work of the State dune, as carried out at the present day, the methods are simple, but constant attention is given. M. Grandjean told us that in the Forêt de Lege et Garonne he had used only clayonnage and gourbet for the last ten years. In the Forêt de la Teste the rule is to have clayonnage along the top, 3 cordons simple on the side and gourbet. In the clayonnage the small twigs on the branchlets should be cut short. The fence is 3 ft. high, or more in the hollows, and loose enough to let sand percolate easily.

A very interesting part of the littoral dune was seen in the Forêt de la Teste where the dune had got out of alignment, apparently owing to a change in shape of the foreshore, and is being

rebuilt partly behind and partly in front of the present site. There must be enough distance some 100 to 200 metres, between the sea and the artificial dune, to furnish the needful amount of sand to create the latter. The first natural dune is about half mile from the sea.

Where the dune was being moved back the loose sand was progressing at the rate of some 10 m. a year and seemed to be in an almost semifluid condition. Another part of the dune was in a young stage of being built up *in situ.*

When the dune has moved back into its right position or is being formed and has already the proper shape and position, the gourbet is planted or sown, generally the first. The planting season is November to February. It is dibbled in about 1 foot deep. The gourbet is planted 1 m. apart near the sea at the base of slope and 30—40 cm. (12″—16″) apart near the top of the dune. The effect of the tussocks in collecting sand is very clearly seen, and the dune rises steadily. Again they are thinned out when necessary. Sowing of gourbet requires 10—15 kilos. of seed with 4—5 kilos. of *Genista* per hectare and 100 faggots of 20 kilos. each to lay over the seed; cost 175 frs. per hectare (£2-16-0 per acre). The work of planting and thinning the gourbet is done mainly by women. The thinnings are done in August-September yearly. The cost of keeping up the littoral dune averages 200—300 frs. per kilometre. It requires constant attention and the whole is gone over at least once a year. In the ordinary way after completion of the dune no other work is required than superficial hoeing (piochage superficiel) which is done in the summer. There is a forest guard for every 7 kilometre length of the littoral dune only. Both (E. and W.) sides are planted. The effect of the blown sand on the adjoining forest vegetation, if the east side remains unplanted, is extremely bad. No grazing is allowed.

2. *The protection belt of the forest.*

The forest vegetation commences in the hollow immediately behind the littoral dune. It is all of artificial origin.

On the *edge* of the forest all the trees old and young assume a creeping position—they creep away from the sea and the wind.

The reason is that the leading shoots are desiccated by the blown sand. The value of the shelter which the trees get from unevennesses in the ground and from each other on the leeward side is seen very clearly at Mimizan where the height growth may be viewed rising in a strongly inclined plane. Near the shore the needles of *P. maritima* are much more strongly developed and the flowers and wood less so than further inland. The cause lies in the struggle of the tree for existence against adverse influences.

In this littoral zone all the underwood is kept, partly for protective purposes and partly to furnish material for fascines, fences, etc., of the littoral dune. Only irregular selection fellings are made and some resin tapping is done.

The littoral dune and protective belt average less than a kilometre in width. Where the littoral dune has been wiped out by erosion as in a part of the Forêt de la Teste, naturally no protective belt is required.

3. *The Commercial Forest.*

The remainder of the State forest area is under regular management for the production of wood and resin. In the Department of the Landes the acreage of the State forest is only about 5 per cent of whole area under forest. The private forests are also under regular management. In the Forêt de Lege et Garonne, and Forêt de Lacanan the lettes (drained marshes) are private and the dunes are State. This produces a curious complication of boundaries.

MANAGEMENT.

The management is simple and effective and is arranged largely with reference to the production of the resin.

The method of treatment is clear cutting with natural regeneration and thinnings. In the forests visited the rotation is variously 75, 70 and 60 years. The first finds most favour and it only need be considered here. In the Forêt de Ste. Eulalie at Mimizan with a 75 years' rotation there are five felling series of 15 coupes each, excluding the protection belt. One coupe is cut for a final

felling each year but, as will be explained later, the four penultimate coupes are also being worked for resin (gemmage à mort), making one coupe in each felling series. The State forests are a narrow strip along the shore of the Bay of Biscay and in the Forêt de Ste. Eulalie the area is divided up into rectangular blocks by fire-lines which run N. and S., E. and W. at every kilometre. The coupes are compact blocks not strips.

REGENERATION.

Pinus maritima is an abundant and regular seed-bearer, commencing at 12 years or even less to produce cones. At the same time though a tree with stocky needles, it is a strong light demander from its earliest youth. Seedlings once badly started with insufficient light never come to anything. In the year preceding the coupe razé all the poor thin seedlings under the canopy are removed. The same treatment might be tried with *P. longifolia.* An inspection of a final, nearly cleared coupe in the F. de Lege et Garonne on May 14th showed only a few tiny seedlings germinated one or two months since, fresh cones on the tops left on the area which will open and discharge their seed (*P. maritima* cones sometimes remain closed for a year and the seeds dormant for two or three years) and there is also the seed which will be blown from the adjoining forest. All this will be enough. Areas similarly regenerated from four to nine years ago show a growth of bushy plants, few indeed to the acre but remarkably healthy, with gorse and broom as accessories and, at Lacanan, a good deal of oak which however comes to little on the pure sand. Only occasionally is any artificial regeneration required in the State forest to fill the blanks as in some of the lettes.

How vigorous the growth is at first, after giving the plants full light, may be judged from the fact that a stump showed 15" diameter for the first 15 rings.

In the Forêt de la Teste (State) the coupe seen was as much as 150 hectares (375 acres), but in private forests it is often more. A good instance of natural regeneration was seen in an area of 500 hectares completely cleared by fire in May 1893. The cones were

on the trees and were opened by the heat, so the result is a perfect regeneration. We were told that had the fire occurred in the autumn when the cones would have been on the ground and been burnt the results would have been disastrous. In private forests a good deal of the regeneration is done artificially often with the help of the plough. The distance between the lines is as much as 7 metres in places, but 3 metres would be a limit for obtaining a *forest* and the ordinary distance would be 1½ metres. Still in every part of the treatment, both State and private woods are kept very open.

THINNINGS.

These commence at ten years and are made every five years subsequently. It may be said at once that all trees are marked five years before fellings of any kind so that the resin may be extracted. The thinnings are made very heavily and, with the first, the lower branches are cleaned by pruning upwards to a sufficient height to ensure a clean bole for the tapping later on.

CLEANING BRUSHWOOD.

In the Forêt de Ste. Eulalie (Mimizan) the underwood is cleaned every five years for the sake of fire-protection. With this the lower branches are cleaned, as above, by daily labour, and weedy saplings are cut out. The cost is 2 to 10 frs. per hectare and the implement is a long handled billhook. In other forests the brushwood is not cleaned. In any case the soil covering is very light and, if fire can be kept out, the presence of the broom and gorse is highly desirable.

On the whole the quality of the forest is moderate which is no wonder considering the poverty of the soil (while the tapping also has its effect in slowing down the growth). The best forest at Lacanan shows a height of 55ft. in 55 years and in Ste. Eulalie of 80ft in 75 years, but the average for the latter would be 50ft. or so. The diameters are proportional, the growth being moderate after the good start. The proportion of crooked trunks is striking.

Two hundred and fifty trees per hectare are given as the crop at the final felling with 75 years' rotation, but the average appeared to be a good deal less.

EXPLOITATION.

The final coupes are sold for resin extraction and wood together for five years, *all the exploitation including the tapping being done by the purchaser,* who pays 1/5th of the price each year. The rules of exploitation ensure the cutting being delayed as long as possible so that the maximum amount of resin may be got.

The timber all finds a ready market. It is used for mine timber, telegraph poles, boxes, etc. Most of the timber is exported for mines to Continental countries and Great Britain. That to the latter is unbarked because it is said that thus cracks can be seen better when the timber is in position in the mines. All for the Continent is barked at once after felling. Mine timber varies from 2 to 2·75 metres in length according to the importing country and the smallest diameters are 8 to 13 cm. (3" to 5"), so that even the smallest thinnings are useful.

In a saw-mill for packing cases a drying chamber was seen; the sawn timber is kept in it at 100° F. for three or four days.

The telegraph pole installation is simple. The poles are 12 to 13 m. long and the bark is kept on during impregnation. The tanks are 10 m. high and less and the liquid for injection in ratio of 1 kilo. $Cu.SO_4$ to 100 litres of water. The poles are arranged in two long rows of 200 poles each, butt to butt, with the main pipe for the injection placed between them. The butts are raised about 2½ ft. above the ground level over a trough which catches the waste liquid. From the main pipe a tube with a tap and a nozzle is connected to each butt, the nozzle being a flat block of wood and circle of rope rivetted on to the butt temporarily. The sap is forced out at the lower end of the pole, the colour of the latter showing when the injection is completed. The process takes 12 to 15 days. The method appears to be a suitable one for India. The reason why creosote is not used is because it is found that the heartwood of *P. martima* is untouched by the creosote and

rots quicker than when treated with anything else. With beech in England this difficulty is not met with.

PRICE.

The final coupes for five years' resin and timber work out to from 1,200 to 2,300 frs. per hectare gross. The net revenue for the whole of the Ste. Eulalie forest amounts to about 50 frs. per hectare (16s. per acre). Of this about half is from resin and half from wood. On the whole, though the' wood is the more valuable.

FIRE.

Protection from fire is a serious business. Mention has already been made of the clearing of brushwood. The forest is also divided into rectangular blocks of one kilometre each by fire-lines. These fire-lines are 10 metres wide. They are cleared every third year in June, July, and are marvellously clean owing to the ease with which the soil cover is removed. They are cleared with a flat spade and rake or with a flat implement for cutting the vegetation forwards and backwards not useful for India. The bad season is March, April, and again, July, August. Where the brushwood is cleaned, the danger is much diminished. Even in private forests it is said not to be great. However clean burns of 500 h. in 1873 in the Forêt de la Teste and of 600 h. at Lacanan in 1899 tell a different tale; in these forests the brushwood is not cleaned. In La Teste the temperature goes up to 104° F. in the summer. Near villages a good deal of the litter is removed for stables. In case of fire the blazes burn and the wood must be cut at once. After a fire, the trees are left for five years without being tapped.

There are no fire-lines along the railways, but watchers are kept at every kilometre during the dangerous season. The engines have spark arresters.

COMMUNICATIONS.

The State forests are well supplied with railways.

Roads are rough and cheap, the sand being dug out and layers of branches, of a little sand and of needles, being put down successively.

Carriage is done by mules and a 2-mule cart takes up to 1 ton. In Lacanan the improvement in communications, railway and road, between 1897 and 1907 has resulted in an increase in revenue from 57,000 to 648,000 francs. Formerly all the thinnings had to be left to rot on the ground—now the wood from them is used for mine props.

RESIN-TAPPING.

This is divided into gemmage à vie and gemmage à mort. In the State forests the object of working during the period of gemmage à vie is to keep the trees in as healthy a condition as possible, while extracting a fair amount of resin. The proportional value of the wood and of the resin during the rotation has already been noted; all the wood is put on while the trees are being tapped à vie. In India this is at present the only method. In gemmage à mort which is applied to both thinnings and final felling, the object is to get as much resin as possible out of the tree during the last five years of its life without killing it.

It may be stated at once that the French forest officers think that the growth of the wood is slightly diminished owing to the tapping, but they submit that it is made more elastic and its quality thereby improved.

GEMMAGE A VIE.

The minimum girth for tapping in State forests is 110 cm. (44″)—about 35 years' growth. One blaze is put on for 110 to 130 cm. (52″) and two above 130 cm., but the latter is by no means always carried out. In the protection belt the minimum girth is 90 cm. (36″).

The revised rules for the forests at Mimizan fix the width, height and depth of blazes as follows:—For width, 1st year begin with 9 cm. (3·6″), end with 8 cm.; 2nd year begin with 8 cm., end with 7; 3rd year 7 and 6; 4th 6 and 5; 5th 5 and 5 (2″). For height maximum for 1st year, 60 cm. (24″); for 2nd, 60; 3rd and 4th, 65; 5th, 70 cm.; total 3·20 m. (10′6″) for five years. Depth

maximum in middle of blaze 1 cm. (0·4"). The old rules allowed a longer blaze and width varying from 9 to 7 cm.

The gemmage à vie is continuous. As soon as five years has been finished on one blaze, the next will be begun. The whole forest will be under this tapping except that part under gemmage à mort. A rule to find the age of a tapped pine in State forests roughly is to multiply the number of blazes by 5 and add 35. The tendency to lower the dimensions of the blazes in State forests, as also in some private forests, shows that the tapping of recent years is considered by the French officers to be too hard on the trees. The vitality of the tree is judged from the *continuity* of the flow of resin.

Generally speaking the private forest owners begin their tapping much earlier even on young poles 20 to 25 years old; with them the production of resin is the principal object. On the other hand some of the even aged mature forest is better and older than anything seen in the State forest and here two blazes are often seen on trees tapped à vie. The cuts are narrow but long, sometimes as much as 1 metre a year and old and new crowded as thickly as the tree can carry. Thus near Mimizan a pine of 164 cm. (66") girth had 11 blazes old and new. Another in the private Forêt de Lege et Garonne (Arcachon) had 13 blazes, hardly any of which had healed up: the tree was healthy with the exception of some fungus (? Polyporus) on the old blazes, and M. Grandjean did not consider it overworked. On the other hand in the private Forêt de la Teste the excessive tapping has been too much for many of the old trees. The wood has split inwards from the cuts, in a few cases from several of the latter and these splits have joined together, and with the heartwood rotting and the bark and wood between the blazes bulging outwards the lower part of the tree has a swollen appearance and its vitality is ruined. Fungus too appears plentifully on the dead wood.

The French officers think that the State by more careful management gets more resin and a more continuous yield than the private proprietors. The private forests have to be seen to find the limit of tapping.

GEMMAGE EN EPUISEMENT.

This is not important. It applies only to trees which have not attained 110 cm. girth ten years before the final felling is due. The gemmage en epuisement consists in tapping these in the first half of the ten years. On the other hand in some State forests no tapping at all is done in these penultimate five years if the forest is young owing to irregularity of the age gradations.

GEMMAGE À MORT.

In reality tapping before death. This is done in the last five years of the tree's life whether it is to come out in the thinnings or the final coupe. The tapping would be for four years and the felling in the fifth. The blazes and cups are placed round the tree as closely as possible. With the smaller trees, at any rate, *it is a good thing to have the tapping going on at different heights, as this exhausts the tree less.* On the trees to be thinned we often find the blazes so, or on such trees instead of putting in five years on one blaze the cuts will be made somewhat long and the whole blaze finished in three years and another begun then.

The rule for tapping thinnings at Mimizan is one blaze for trees of 50 to 60 cm. girth and an additional blaze for every additional 20 cm. up to four blazes.

In the final felling the cups are mostly on the same level, even though the trees are small. It is a matter of business. There are no rules for tapping in the final felling. The dimensions of the blazes are kept much as before but the sole object of the lessee is to get as much resin as possible. (It might be thought that the wider blazes in use in America would effect this better.)

Some instances of trees tapped à mort may be given:—(1) A pole of 63 cm. (25") girth had less bark than blaze with two blazes in working gemmage à mort in thinning. (2) A tree of 34½" with six blazes, three being in working now. (3) A tree of 106 cm. (42") girth with six blazes, one worked out en epuisement and five in working. Final felling. Each blaze may be 4" wide. (4) A tree of 40" girth with three old and four current blazes. Final felling.

REMOVAL OF BARK BEFORE BLAZING.

The bark is cut off with a straight bladed wde axe to a height of 2′ and width of 6″ or 8″, reaching in the middle nearly to the wood, before the blazing is begun. This is done very carefully from the side. The bark is always cleared well ahead of the blaze. The French officers do not consider this practice detrimental. In such heavily blazed trees as those described above almost the whole outer bark will have been removed round the trunk ! The removal of bark is begun in February.

BLAZING.

The first blaze is generally made on the east side of the trunk. *A point brought strongly to our notice* by the French forest officers is that the growth of the wood (and with it the production of resin) is as a rule much more strongly developed on the east than on the west side of the trees of this locality—possibly the result of prevailing winds ; *this can be seen from the state of the bark* which is more vigorous, thicker and more deeply grooved on the east side of the trunks. This is important because the *P. maritima* forms much denser forests than the *P. longifolia* and the power of the sun which we suppose in India affects the resin producing capacity of the trunk does not come into play to the same extent in the Landes. Not that there appears to be much difference in the temperatures of the Landes and of the Himalayas between 3,000 and 6,000′.

Little enough seems to be known about the effect of the tapping on the production of resin, but judging by the presence of the highly resinous wood in the butts of *P. longifolia* which are being cut for torchwood, and from the admission of the French forest officers that the more the resin extraction the less the wood production, we may surmise that the tapping or wounding of the tree has the actual effect of diverting the wood producing power to the production of an abnormal quantity of resin, the particular substance with which the pines cover their wounds and keep out injurious influences.

The blaze then is begun at the base of the stem which is not swollen in the *P. maritima* as it so often is on the *P. longifolia.*

The trunks of the *P. maritima* are often crooked and lean towards the east. *The blaze is kept parallel to the axis all the way up.* The illustrations Nos. 380, 382, 383 of Schlich's Manual, Vol. V, 2nd edition, give sections of blazed trees and show the *concavity* of each blaze. This is undoubtedly the right method. The blazing implements *with curved edges* are described below. As stated above, the blazes are very shallow, limit 1 cm. and by cutting and not tearing the cells on the sides as is done with a straight-bladed implement, all the resin cells are cut through, the maximum of resin is obtained and the cuts ought to heal more quickly.

At Mimizan (Forêt de Ste. Eulalie) the cuts are freshened about 40 times a year, *viz.*, once a week from 1st March to 15th June, once every five days 16th June to 15th September and then once a week up to 15th October or 1st November. A little further north at Lacanan we were told that near the northern limit of turpentining the freshening of the blazes must be done more often than further south. The two statements are slightly contradictory.

Note.—We are informed by M. Malepeyre Inspector who has had experience of hotter climates that in Algeria the *Pinus halepensis* is tapped only in the spring and the autumn. There is no flow of resin in the summer, owing to excessive heat! Perhaps we might compare the *P. longifolia* at 2,000′—3,000′ elevation with this?

HEALING OF THE BLAZES.

Even with the methods and instruments used the blazes only heal over slowly. On an average tree under gemmage à vie on which there were four blazes of 3½″ width it was seen that the oldest had not completely covered in any part. The average time for healing must be put down at quite 20 years. The longer the period of healing the more the danger of rot and fungi getting in.

Zinc lips.—These are thin.

Pots.—The pots are only emptied once a month, *viz.*, about seven times in all during the season. This seems odd! The pots are circular in section, 6″ in diameter at the top, 3″ at bottom and 3½″ deep. They are glazed inside and are not bored to receive a

nail. In fixing on the trees, they are neatly wedged ***between*** the lip and a long soft nail, 3″ or so in length, of which 2½″ remain outside and ½″ to ¾″ penetrates the wood. The nail has no head but the top is slightly roughened, I believe.

The pots are hung approximately vertically below the highest point to which the blaze will reach during the year. Most of the trees are crooked and when necessary, as is often the case, the resin is guided by small shavings or strips of wood neatly fixed in the stem (the instruments abshot and rasclet have small straight cutting parts at the back for doing such work). The position of the pots is not changed during the season.

Instruments.—For scraping the bark on high blazes prior to using the rasclet, the barrasquit d'espourga is used, a hook-like implement with a blade 3″ wide and long handle—***vide*** Plate 27, fig. 1.

For making the blazes there are two instruments, the abshot and rasclet. The former is the principal. It is of a peculiar shape, a cross between an axe and gouge with the edge at right angles to the handle—***vide*** Plate 27, fig. 3. It is held from the side with the handle, 4′ long, between the legs, and requires a good deal of skill but very little effort to use. It is doubtful whether a hillman of the Himalayas could use it. The cut is always begun in the *middle* of the blaze-to-be. The cost of the tool is about 6 frs. in the Landes.

Another kind of abshot with edge, still curved, parallel to the handle is used in private forests. The edges of all these instruments are kept like razors.

In the State forests ladders are not used for high blazing but a long handled instrument, the rasclet, is carried. It is simply a gouge bent so that it can be used from below, Plate 27, fig. 4, and it is ***drawn*** down the cut. It has a handle 7′ long Theinstrument used for affixing the zinc lips, the pousse crampon, is very neat, Plate 27, fig. 5. It is a flat gouge, of the shape of the lip with a grip behind the edge to hold the lip so that the two operations of making the cut and fixing the lip are practically one. Price 5 frs.

For scraping the resin out of the pots, the flat pallinette is used, Plate 27, fig. 2. Note the curve at the bottom.

The pails for carrying the resin have a useful bar across the top for scraping the pallinette on.

Most of the above tools could be made with difficulty in India.

Small wooden reservoirs or wooden barrels of *P. maritima* wood half buried in the ground are used for storing the resin temporarily in the forest.

The barras or resin which solidifies on the blaze is also collected, a sack being spread under the tree and the barras scraped on to it. The instrument for scraping is called the barrasquit de barrasqua and is very like the b. d'espourga but the blade is only $1\frac{1}{2}''$ instead of $3''$ wide.

The outturn.—One or two points may be noted. The smaller trees on the dunes with more light give proportionately more resin than those in the hollows.

An average pine tapped à vie gives slightly more resin with one blaze than a pine tapped à mort, although the latter has two to three blazes on the average. This may be accounted for partly by the small size of the latter trees, which owing in part to the irregularity of the age gradations give only about ·16 ton of wood or say 9 c. ft. each.

Exceptional trees give exceptional outturn. One of 164 cm. (66″) girth gave 74 litres (16 gallons) resin per year for five years with five scars.

The best resin is produced in the spring.

Each labourer is paid half of the resin which he collects as his wages, and nothing more. Fourteen men can work 100 hectares or 700,000 blazes. The average man works three days a week on the blazes and one day on collecting resin. The whole works out to about 7 frs. wages a day.

Prices.—Dax and Bordeaux are the two chief markets for this area. The prices always follow American prices. Present (May 1909) prices 2 frs. per gallon for turpentine ; 9 frs. per maund of 80 lbs. resin ; $6\frac{1}{2}$ frs. per md. brais ; 1·10 frs. per gal. resin.

MANUFACTURE.

In the Landes we find two classes of resin distillery, the one such as our own at Naini Tal and Kalsi, simple and with a good deal of hand labour ; the other complicated and expensive in which hand labour has been largely dispensed with. This latter is especially suited to private enterprise.

In the simple distillery of a good type we find the following : —

(1) Large cisterns with cemented sides under cover in which the resin is stored on being received from the forest.

(2) The distillery proper consisting of a small cistern, boiler, steam generator, condenser, and turpentine separator.

A small cistern with a plug at the bottom receives the resin from the large cisterns, instead of its being poured direct into the boiler. It is connected with the latter by a pipe 3′ long. This method simplifies the introduction of the raw product into the boiler but *appears* to have no very great advantage, as one still is always completely finished before another is begun.

The boiler is of the ordinary type about 3′ high and 3′ in diameter. There are two nice points about its construction. One is the introduction of the thermometer and the other the connection between the top of the boiler and the condenser. The mercury thermometer is a large instrument encased in a brass pipe perforated at the bottom, and long enough to reach nearly to the bottom of the boiler, *viz.*, some 3 feet. The scale remains outside of course and *the whole is movable* through a socket in the top of the boiler. The maker of the thermometer seen is L. Maxant, Paris. Price including socket 40 frs.

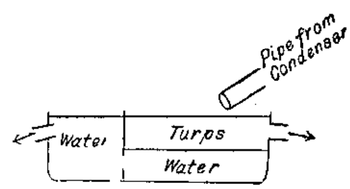
The rim of the boiler-end of the connecting pipe of the condenser fits loosely into a slot round the top of the mouth of the boiler which is filled with water. Thus without any rivets the connection is vapour-tight. This is neat and handy. The furnace below the boiler is of the ordinary type for wood fuel, and water is introduced into the boiler from above as usual. There is also a steam generator of a simple kind from which steam is brought through a pipe reaching to the bottom of the boiler. The permeation of the resin by steam, we are told, forces out the turpentine

and makes a difference of 10 per cent in the outturn of the latter.

The crude resin is not cleaned before being boiled. It is not so dirty as in India owing to the scraping of the bark above the blaze, but a fair quantity of bark, larvæ, etc., passes out with the rosin into the strainers and on the whole the Indian method appears preferable.

The connecting pipe of the condenser is of a useful shape. It is only 6′ long but very thick, 9″ or so, and the condenser itself is very large compared with ours; the tank is 8′ in diameter, and 8′ high with a corresponding spiral of 6″ pipes. The boiling and distillation appear to be done rapidly. The turpentine and water in mixture flow from the condenser into a small tank in which the two substances are separated automatically.

It is something of this shape—the exact form could be determined by experiment. The last part of the turpentine which comes off is redistilled here also.



The whole distilling apparatus is compact and comes into a space of 20′ × 20′. The process is short, in fact in a *second* class distillery of the simple type with no thermometer and no steam generator, which we also saw, the distilling is completed in an hour!

After being cleaned by pouring off through several sieves as usual, the colophony is poured into barrels of *P. maritima* wood *while still in a hot liquid state*. It is a manifest advantage to be able to transport it in a solid mass.

The colophony hereabouts is classified into 7 or 8 grades only according to colour. In the distillery of the elaborate type of Messrs. Dupouille seen at Pontenx near Mimizan, the detailed machinery of which was beyond me, the inferior colophony (brais) is run off from the boiler into trucks and thence poured hot into wooden casks. *The superior kind is bleached* by pouring into thousands of shallow zinc pans of about 2′ diameter, to a depth of not more than 3″, and exposing to the sun's rays.

The turpentine is stored in large cisterns of rivetted iron kept well leaded, and is transported in wooden casks or galvanised iron cisterns.

Uses.—Among other things, turpentine is being used now in the manufacture of artificial camphor.

Rosin, besides its commoner uses for soap, paper and sealing-wax, is redistilled and mixed with soda bicarbonate to make machine oil and is also used in the manufacture of printing ink.

CONCLUSIONS.

This account may be compared with that given in Schlich's Manual, Vol. V, second edition. Mine is nothing more than the account of a week spent in the Landes—it cannot be complete. To sum up, after a study of the work in the Landes with *P. maritima* we ask ourselves (1) what place we are to give the resin work in the management of the *P. longifolia* forests in the Naini Tal Division (or others also). Is there any need of, or any useful purpose in modifying the management during the next felling period for the whole or any part of the Naini Tal chir areas so as to make the resin work easier? (2) Can we do anything further in our work of gemmage à vie, can we make the tapping continuous above a certain girth or more continuous than at present, that is to say, shorten the period of rest? Should we alter the dimensions of the blazes or their shape, should we introduce other tapping implements? (3) Can we do anything in the way of gemmage à mort? in thinnings or final fellings? in fuel or timber fellings? is it worth while to do such tapping for a shorter period than five years? (4) Can we do anything to improve or economise the manufacture—by storing the resin in cisterns, by using thermometers in boiling, by steaming, by using turpentine separators, by bleaching the rosin, by transporting differently so as to reach the consumer in a cleaner state?

To these questions I would answer briefly (1) the resin work must take a secondary place in the management of the hill forests of the Himalayas. The best method of treatment for resin work, that of clear cutting, cannot be used. On the steep slopes of the

Naini Tal subdivision, in which moreover the pure chir forests are not compact, it is very doubtful whether we can advance further than the group method, and neither the group nor selection methods are well suited for intensive resin work especially when the demand for rights timber is so large. (2) Looking at the French gemmage à vie it would certainly seem that we ought to try to make our tapping more continuous, especially of trees of the larger girth classes, and, I may add, especially if we only tap the lower 7′ or 8′ of the butt. Where the pine is only required for fuel, the tapping should be heavier, both in longer blazes and more of them.

It will have been noted above that the French do not expect the blazes to heal over very quickly. We might reduce the width of our blazes and we ought certainly to employ tools with curved edges. I do not think that the French blazing tools would be found suitable for hillmen with the exception of the rasclet. An adze with a curved edge would be the thing, I think. The keeping of the blaze parallel to the axis of the tree, and the insertion of slips of wood to guide the resin into the pots are among the points to which attention may be drawn. There are many experiments possible under this head.

(3) In the Landes about half the resin is obtained in gemmage à mort. It seems that much might be done at least in fuel working circles in the Himalayas. The question for a period of how many years less than five the resin tapping could be made a paying proposition can easily be worked out. (4) Undoubtedly very considerable improvement can be made in the manufacture under the heads indicated before. Probably steaming greatly reduces the period of distilling besides increasing the outturn.

One point remains and that is that it should be possible to obtain the monthly variations in prices if not in France and the U. S. at least at our principal ports. The price of turpentine in France in May 1909 was only Re. 1-4 per gallon.

R. C. M.

11th July 1909.

FORESTRY EDUCATION: ITS IMPORTANCE AND REQUIREMENTS.*

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I propose to deal to-day with a brief exposition of the points on which the system of Forestry Education is based. I hope thereby to show what this University requires to place its Forest Department on thoroughly up-to-date lines, and thus enable it to turn out men as efficient and capable of managing woods as are the men trained in the various famous Forestry Schools of Europe.

It will be of interest, I think, to first glance briefly at the training to be obtained at some of the European Forestry Schools and the facilities provided for giving it. We will then consider some of the things the student in Forestry must know, and in this connection glance briefly at a few of the duties which confront the Forest Officer in the course of his ordinary work in India, concluding finally with a review of the present position of the University as regards Forestry training and the steps which require to be taken to enable us to send out the class of British forester which is already required in many of our Colonies, and for which we trust there will soon be a demand in the British Isles.

A few years ago, whilst on furlough from India, I made a tour of some of the Forestry Colleges and Schools of Europe, my object being to study the lines upon which the continental system of education was based, and the methods they adopted to combine a proper proportion of practical work with the theoretical instruction given in the class-room. In the course of my tour I visited Eberswalde, Tharandt, Aschaffenberg, and Munich Forestry Schools in Germany, the Imperial Forestry Institute at St. Petersburg, the Agricultural and Forestry Institute at Vienna, and the fine French Forest School at Nancy. That tour was an education in itself. Briefly I may sum up the results of my observations as to the essentials for the tuition of Forestry thus :—

1. A Strong Teaching Staff.
2. Good Museums.

* Inaugural lecture delivered at Edinburgh on 12th October 1910.

3. A Forest Garden and Forest Educational Woods.

1. *The Instructional Staff.*—The study of Forestry so depends on a number of cognate subjects, such as botany, chemistry, geology, zoology, surveying and forest engineering, etc., that it is essential that the student should be given first-class courses in these matters. Excellent courses are given in all continental colleges. There remains the subject of Forestry itself, comprising the various branches of sylviculture, forest management, forest valuation, forest protection, forest utilisation, the law of the forests and procedure and accounts. To lecture on these various branches the best continental colleges retain the services of at least three men, Professors and assistants, many of the former having world-wide reputations in their various branches. These men are also often responsible for their own departments of work in the school forest garden and instructional forests. Their work, as we shall see, falls under two heads. They deliver courses of lectures in the lecture hall, and they conduct the students on the excursions made into the woods to illustrate these lectures, and they personally supervise every piece of practical work laid down for the student to do. Since the minimum time in which a student can finish the Forestry course is two years, the Professor requires at least one assistant to conduct a part of the lectures, for the junior and senior students are both necessarily attending courses at the same time, and one lot may be in the woods whilst the other is in the lecture hall. At the well-known Forestry School at Munich, the home of a number of famous Foresters, the various branches of Forestry Science are in charge of three Professors. Prof. Mayer takes Sylviculture, Forest Utilisation, Protection and Foreign Forestry; Prof. Endres, Forest Policy, Adiministration, Valuation and Finance, whilst Prof. Scheffer lectures on Forest Management and Working-plans, Estimation of Increment and Yield. Each of the Professors is responsible for the excursions, laboratory and practical work of his various courses.

2. *Good Museums.*—The educational value of a good museum is fully recognised. It need not be enlarged upon here. Forestry is peculiarly a science whose tuition on the one side and assimilation

on the other is dependent upon two essentials. A thoroughly efficient system of practical work and up-to-date well-planned museums exhibiting in a simple and efficient manner the various details connected with forest work.

So important is the museum as an adjunct to the efficient teaching of Forestry, that we find that considerable sums of money have been spent in all the continental forestry colleges on this part of the equipment alone, and yet in some instances, although with treble the space available here in Edinburgh, the cry was often that more room was required. Where all is so good it is difficult to particularise, but as examples of efficiency in this respect, I will instance the museums at the Forestry School of Nancy in France, the Imperial Forestry Institute in St. Petersburg, and the Forestry College at the University of Munich. The latter, so far as its building accommodation and museums are concerned, forms the nearest parallel to the position of Edinburgh University and it will be of interest to briefly glance at the accommodation provided.

The Forestry College at Munich forms part of the University of the town and State, and considerable sums of money were spent a few years ago with the object of bringing it thoroughly up-to-date. The buildings devoted to Forestry instruction are two in number, both situated in the grounds of the University. The old building contains the museums and rooms devoted to Botany and Zoology. The accommodation for each of these sections consists of a commodious lecture hall, professors and assistants' rooms, packer's room, and two fine rooms for the museums. It is outside the province of these remarks to deal with the contents of these museums, but I will say that they merit the closest inspection of any forester who wishes to educate himself in this direction.

The new building which was opened about the year 1900 is the most perfect institution of its kind that man could have devised. The whole of the inside fittings are of wood, highly polished parquet flooring being used throughout, whilst the rooms are handsomely panelled with various kinds of woods. The chemical, mineralogical, meteorological laboratories, etc., are in the basement ;

forest surveying, mathematics, and forest wood museums on the first floor, and forest implements, forest products and models and diseases of woods on the next floor. Each of these branches or departments of science has its own museums, one or two rooms as are required, its own large lecture hall with professors and assistants' rooms, laboratories where required, packer's room, etc.

I am chiefly concerned here with the accommodation afforded to the Forestry branch, the chief branch of his work for the Forestry student. A room each is devoted to the sections of Forest Surveying and Forest Mathematics, with adjoining professors and assistants' rooms. A large room is devoted to exhibits of the different kinds of woods with a fine lecture hall and professors and assistants' rooms close by. On the next floor we have a hall devoted to the exhibition of the implements and instruments used in the woods for various forest operations, such as sowing, planting, trenching, pruning, felling, etc., a very complete collection. In this hall, which is a very large one, is also exhibited a fine collection of the products and articles fashioned from the wood by the implements exhibited, *e.g.*, all stages in the manufacture of matches, fashioning of cart wheels, rakes, harrows, etc. The walls are hung with numerous photographs of felling operations, logging, planting, etc. This opens into another large room which is devoted to models and general forest products. We see here an almost unique set of models required for the extraction and transport of forest produce such as slides, sledges, rope-ways, bridges, etc., etc. The collection of what are known as the minor produce of the forest—gums, waxes, edible seeds, tannin, etc., etc., is exhibited here. A fine lecture hall and professors and assistants' rooms adjoin.

The above description will show that there is little fault to be found with the arrangements and space devoted to this wonderfully efficient forestry college. With such equipment there is every incentive to professor and student alike not only to work but to undertake research work in the various branches of Forestry. In the Bavarian University the State pays for the upkeep of the major portion of the Forestry Department, and in return the Government reaps the advantages derived from the very important

research work and experimental work in which its professors, many with great European reputations spend all their spare time.

3. *The Forest Garden and Educational Woods.*—We come now to our third essential to the proper teaching of Forestry, the forest garden and educational woods. It may be said at once that the subject of Forestry cannot be taught by the professor or assimilated by the student unless efficient instructional woods are available to which the student can be taken during the lecture course, as well as during the practical course, to be shown eye object-lessons of what he is told. He should be shown in the woods what he is told in the lecture room, and taught to observe for himself—that first and most important of the lessons of a forester. These first principles of the education of a Forestry student are well understood on the Continent, and are adequately provided for.

I will give two instances out of many. The German Forestry Academy of Tharandt is situated not far from Dresden in Saxony. The school is provided with a forest garden and demonstration forest, forming a compact block in its immediate vicinity. The forest garden is situated on a hillside immediately behind the school. The hillside is terraced into beds which contain some eighteen hundred different species of trees, shrubs, perennials and annuals of various kinds, both indigenous and exotic. This garden serves as a forestry and botanical garden, and is an exceptionally fine one, covering an area of about eighteen hectares. There is a forest nursery in the garden managed on most up-to-date lines. For instance, rare exotic seedlings or those difficult to grow are raised in seed beds placed in brick cells covered with a wire-mesh framework, which secure an entire immunity from the attacks of insect pests. Very few of the seedlings raised in these beds are lost. There are some glass houses in the garden in which experiments in connection with the grafting of conifers were being carried out at the time of my visit.

The school demonstration forests adjoin the forest garden, and are kept up entirely for educational and demonstration purposes. They are situated in a hilly area presenting ever-varying conditions,

aspects, and variations in soil, thus allowing of a variety of object-lessons with different species and mixtures being presented to the student. For example, these woods contain spruce and beech with birch in mixture ; spruce and silver fir, or the two latter with birch. Or again, there are woods of spruce, beech, Scotch pine, silver fir, larch, maple, birch with maple, and various mixtures, ash (pure, about thirty years old), alder (in wet valleys), oak, and a little Æsculus. There are some most interesting mixtures to be seen doing remarkably well, and forming an ideal of what demonstration woods should be. The steep slopes of the hillsides are worked under different sylvicultural systems to the area of tableland above, where the woods are clear cut and naturally regenerated or sown or planted. Exotics are being largely introduced, and thousands of plants are sent out annually from the forest garden and nursery in the demonstration area into the forests all over Saxony. Fencing of young planted areas, and other ways of protecting young plants from deer, etc., are to be seen in practice in the woods. Time will not permit of my dwelling upon this excellent educational demonstration area, but from his earliest course in the lecture room, the student is taken out week by week into the forest garden or woods, and with his own hands learn how to trench, sow, plant, thin, and fell and measure up his woods ; he is taught to distinguish the different species of tree, and how they differ in their requirements of soil, light, moisture, etc.; he is shown on what the foundations of sylviculture depend ; and is gradually led step by step and stage by stage to understand and grasp both the theory and practice of the various branches of the lore of the woods comprised in Forestry.

I should like to give another instance of this educational forest. The Imperial Institute of Forestry at St. Petersburg is probably the largest forestry college in Europe. The students number five hundred, all training for the Controlling Staff. In addition there are thirty-three lower grade schools scattered about the country containing fifteen students apiece, from which the ranks of the forest rangers and upper guards are filled. Attached to the Institute at St. Petersburg are two educational forests, the one 14

versts (9 miles) from the capital, the other and larger 60 versts (40 miles) away. At each of them, buildings are maintained for housing the professors and students during their visits. Portions of every summer are spent by the students in these woods occupied in practical work. The woods are entirely under the management of the Director of the College, as is the case at Tharandt, and are managed on similar lines and solely for demonstration purposes. The Directors at both these places, as also the Forestry Professors (and this applies to many of the continental colleges), are all practical men who have themselves been through the mill of executive work, have themselves held charge of large areas of woods worked entirely on a commercial basis, and are therefore in a position to see that the instructions given to the students is such as will return full value to the State or proprietor who employs the men leaving their institutions.

This is a point which I think worthy of the most serious consideration in this country. Too great stress cannot be laid on what are, after all, actual facts. The excellency and remunerative results of Forestry in Europe, which we also wish to arrive at in the British Isles, are solely the result of the study of Higher Forestry both in the woods and in the laboratory. Practical foresters can only be successful in proportion to the knowledge they themselves possess or which is imparted to them by those who know. We can learn from other countries a great deal, but the application of what we learn must depend on ourselves and must be carried out by ourselves.

We have now seen what the continental forestry colleges consider the essentials to the proper tuition of Forestry as a science and have shown how the student is gradually led, not only to assimilate the theoretical portions of the study in the lecture room, but to take with him what he has absorbed there and apply it practically in the woods. We have seen that these practical object-lessons must begin with the student's first lectures, that he must be taken into the woods at the beginning and be shown step by step that what he is being told in the lecture room is not so much matter to be studied for an examination,

and to be subsequently forgotten when his text-books and note-books are thrown aside after the "pass" has been gained. It has been said of the forester that he is always at school from the moment he first enters the lecture room to commence his first course to the end of his life. And those of us who are foresters know this to be true. Our text-books and lecture notes remain our trusted friends to the end, and as we grow older and have had a more extensive practice and experience in Forestry, we grow more diffident about expressing definite opinions and laying down the law on the subject of the life-histories of our friends the trees. For the tree is very much like the human being; he has his wants and requirements, his fancies for particular aspects and localities, for certain soils and degrees of light, moisture, heat and shade. All these the forester must know and study, and even then his fastidious friend will often discover something he dislikes and refuses to grow. The forester has to set to work to find out what this something is, and meanwhile, all he has done is a failure—a failure, that is, unless he is a thoroughly trained, scientific man. As such he will turn his failures to account, for he will place them on record so that he and others like him may set to work to get at the reasons for the failure of a crop, which as far as human forethought was capable of doing had been given every chance. How much sound practical knowledge and observation have been lost to the foresters all over the world by this regrettable neglect to place upon record their failures. Almost more valuable are they to record than the successes. To the forester far more valuable. This is one of the spots upon which the scientific forester can place a finger in the British Isles. Had one a full, or even a partial, record of all the failures of the past, how much simpler would be the task at present facing the nation of setting its Forestry house in order.

But a knowledge of situation, soil, temperature, and moisture requirement of the tree will not suffice the forester who wishes to bring his crop from seedling stage to the axe. He must be a doctor and must be able to diagnose the diseases to which his trees are liable; or I will say that he must have knowledge sufficient to be able to recognise the first appearance of a disease, whether

it be one of the fungus pests to which all tree life appear to be subject, or one of the insect plagues, which, if left unchecked, may result in the loss of the major part, if not of the whole, of his crop. It would probably be impossible to estimate the losses to the timber supply of the world from these causes alone. Dr. Hopkins, the Forest Entomological Expert of the American Government, has estimated the annual loss to America from insect attacks to timber and forest produce at something like a hundred million dollars.

There can be little doubt that the greater the ability possessed by the forester to recognise these dangers to his trees, when they first make their appearance, the greater will be the immunity of his crop from them. The greater number commence at a centre, and spread from that point. If the forester is able to detect such a commencement and deal with it at once, he will stamp out the disease, and save his woods. Surely, then, we would all rather have such a man in charge of our woods than one without the knowledge. We require the specialist in all these diseases to aid the forester, but the specialist must depend entirely on the forester for information on these attacks; for the foresters are many in number, but the specialists few. How often is it that the specialist is called in only when the attack has assumed such dimensions that the difficulty of stamping it out is not only very great, but also very costly. And there is no use in blinking facts. The responsibility rests solely with the forester in charge of the woods and nowhere else. If the forester has received an efficient training he will have studied this branch of his profession under able specialists, and will have been shown as a student how to recognise the first beginnings of such attacks. *He goes to his duties then properly equipped, and if he* neglects to report a bad plague before it is devastating his woods, he is failing in his duty to his employer. I speak as a practical forester myself, who has had personal experience in this direction, for I have seen serious damage done in Europe as well as in India (grave damage is being done at the present moment here in Scotland) which could have, in great part, been avoided had those responsible possessed the necessary training to enable them to recognise what was taking place when it first began.

It may be asked, but what are the duties of the Forest Officer when you have turned out this highly trained product. They will, of course, vary with the country he is serving in, with the character of his woods, with the reasons for which those woods are kept up, in fact with the thousand and one conditions which go to make up that whole—the work of a forester, one of the most varied and interesting occupations in existence to the lover of the open air and of nature. It may perhaps be of advantage to dwell briefly on a few pages from the diary of a forester in India, as they sum up duties which a forester will find awaiting him wherever he serves.

That tract of country in Eastern Bengal situated between Calcutta and Burma contains a wonderful variety of different kinds of forest, from mangrove swamps along the seaboard to hills of pure bamboo, alternating with a scrubby jungle growth, giving place to fine, dense, tropical forests in the mountainous ranges of the Chittagong Hill Tracts and Lushai Hills. A veritable botanists' paradise these dense forests, accessible only to small boats poling up stream, for there are no roads, and the whole of the forest produce is floated out. With the varied nature of the forests and a dense population in the flat lands adjacent to the seaboard, come a variety of occupations, including a goodly proportion of the most harassing of a Forest Officer's duties—court work. Pilfering of a few bamboos and head-loads of sticks or illicit grazing of cattle within the forest boundaries was constant. These were minor offences, however, mostly settled out of court. Encroachments on the Government forest boundaries were more important. Wholesale stealing of large logs or dug outs (boats), which were floated down from the forests to the revenue stations on all the large rivers (the rivers form the chief roads of this part of the world), there to be assessed, was rife—the Government marks being removed, which made the offence a serious criminal one. During the monsoon months, on dark rainy nights, when the rivers were out in flood and went roaring past the revenue station at twenty miles an hour, was the favourite time for such work. Once past the station, all was fairly plain sailing. Every village on the river

bank was implicated in this sort of thing. Tanks (small ponds) are as plentiful as plums in a cake in this part of the world, and the logs were taken from the river and sunk in these tanks, where, safely hidden beneath the thick coating of slimy weeds which covered their surface, they could remain till the day of judgment without being discovered! The grave nature of these offences when they can be brought home to the offender usually means days on the bench beside the Magistrate, explaining the intricacies of Indian Forest Law, if one is to make sure of obtaining a necessary and salutary conviction. The inspection of these revenue stations is also heavy work. In the busy season several miles of rafts would be moored off them, consisting of logs of some score of different species of timber, dug-outs, thousands of bamboos, canes, and a large variety of the minor products of the forest, all of which had to be checked and assessed by the station officers. Men capable of undertaking such work required a good preparatory training, and the man required to check their work must have a higher one.

Other days will have to be spent inspecting the boundary lines of the Government Reserves. The Forest Officer is entirely responsible for his boundaries, which may run into hundreds of miles. He must see that they are yearly cleared, that his pillars or boundary posts are all standing in their proper positions. If he thinks any have been removed, he will have to check the bearings with theodolite and compass. Should he fail to do this and allow a boundary to get into disrepair so that it is not plainly discernible to the villagers, a prosecution for trespass or for cultivation illicitly *encroaching on the boundary (a common habit of the villagers)* will assuredly fail when carried into court, and will be followed by an outcrop of such offences. At another time, in the locality I am describing, a number of large areas of forest, some consisting of pure bamboo, others of dense tropical forest trees, had to be carefully inspected with the object of the preparation of plans for their working. I have not time to deal with this aspect of the Forest Officer's work to-day. But a working-plan made for a wood practically lays down for a number of years the methods on which the

wood is to be worked, the cuttings to be made; the roads, slides, tram or sledge roads, or ropeways to be built to enable the timber to be got out; the areas to be sown or planted up; weedings to be done; in a tropical forest the areas over which the giant creepers festooning the trees are to be cut in order that they may be killed before the area is felled over a few years hence, for otherwise they will hold the tree in its position, and it will not fall, though cut through at the base, etc.

The preparation of a plan of working for a forest is one of the most interesting and at the same time most exacting pieces of work which confronts the forester. The forester, without the knowledge of how to properly prepare one, loses an incalculable amount of the interest his profession contains. Before preparing a working-plan the forester must make himself thoroughly acquainted with the land tenure systems of the country in which his woods are situated, with the law of the country, with its botany, so far as it applies to the woods, geological formation, chemistry of the soils so far as it affects his species of trees, etc. He must have an intimate acquaintance with the wants of the local people, with the local markets where he may dispose of his produce, and with those farther afield, to which his large produce may be disposed of at advantageous rates. And all this knowledge he will have to acquire in addition to an exhaustive examination of what the wood contains at the present time before he can draw up his proposals for its future working. These may involve its entire reconstitution, and they must be so laid down in the plan that his successor, or successors, may carry out the prescriptions laid down without the danger of any deviations. For the plan will provide that no deviations whatsoever may be made by the Forest Officer in charge without the direct permission in writing of the owner. And this brings us to the management of woods, for which a working-plan has been prepared. Higher Forestry education is essential for the efficient working of such a plan, for even the simplest requires a good deal of training and experience to avoid mistakes being made which can never be subsequently retrieved. When there is a large demand for the produce of a wood, the plan

is likely to be inevitably somewhat intricate. To quote an instance. I was in charge of the Darjeeling forests in the Eastern Himalaya some years ago. Darjeeling is a large civil station situated at some 7,000 feet elevation. The population is considerable, and there are military cantonments both above and below the station. Out in the district, tea gardens, all requiring forest produce, were situated on the forest boundaries. To supply this population with its requirements in timber, firewood, charcoal, grazing in the woods for milch cattle, and fodder for the horses, ponies, and mules of the station, etc., required a very nice management of the forests. Every stick of timber and fuel could be sold without satisfying the demands. To ensure continuity of working, the forests are worked under highly scientific working-plans, for there are several plans in force in different areas, which have to be followed undeviatingly by the officer in charge. To manage such plans meant a great deal of heavy work for the staff; with the constant rotation of felling and planting, the latter work undertaken during the monsoon in a locality where the rainfall is over 140 inches; the upkeep of roads constantly liable to slips; the preparation years beforehand of export roads or sledgeways or wire ropeways for the extraction of the material from inaccessible localities; the constant friction with the cattle graziers in the forest, a wild, difficult class of men to deal with, and the usual petty pilfering inseparable from forest work in the East, kept the staff pretty well employed, whilst in addition to boundary inspection and fire-protection work, the upkeep of the control forms and books in connection with the working-plans formed no light portion of the office work. Only a highly trained staff could undertake to cope with the management of such woods as I have endeavoured to picture here.

Now woods may be managed or mismanaged without a plan. But no continuity in working of a wood can be assured unless its management is based on a plan, and Forestry without continuity of working is not Forestry. I do not suppose there is a forester amongst us who is not well aware of this. I feel perfectly certain also that no one who has once been into the woods, and seen and understood all that is to be learnt there, but will agree with me

that the more efficient the training the forester who has charge of those woods can be given, the more valuable will be his work, the more enjoyable will be his life, and the better grown and better kept will be the woods in his charge. And what does it all reduce itself to? Any Forest Officer will tell you that the more, up to a certain point, that is spent on the efficient supervision and working of the wood, the greater will be the pecuniary return. It is the sole aim of a working-plan, based on financial results. And we have seen that this is fully recognised on the Continent where they are not given to spending money without obtaining an adequate return, and yet they spend large sums on their Forestry Educational Establishments. A full knowledge, therefore, of what a plan is, and how it should be worked, is one of the essentials we propose that the student taking our Degree Course here shall go out into the woods armed with. He will still have much to learn, but we shall have, we shall hope to have, given him, along with our up-to-date Forestry education, one of the most valuable gifts education can give to a man—the power of observing. A forester who has not this power were better employed elsewhere, for he will never be of any use in the woods. We shall also hope to have inculcated him with the faculty of taking responsibility, and of acting in sudden emergencies.

I have mentioned a few of the duties of a forester. I have not alluded to one of the most severe, that of fire-protection. The danger from fire to the forest in the dry portions of a year is one well known to everyone. But what this danger amounts to in a hot country during the hot season can scarcely be imagined by those who have not seen a forest fire raging along through walls of tall elephant grass with a fierce hot wind behind it. Whether a few square miles or several hundreds of square miles of valuable forest are burnt on such occasions depends almost entirely on the resource and quickness of decision of the Forest Officer on the spot. The prevention of fires or their limitation is often also entirely due to the personal qualities or influence or power of observation of the local officer. May I give an instance of the latter. There is in India a small bird known as the weaver bird which constructs grass

nests having the shape of a soda-water bottle, though often much larger, the entrance being near the base. This nest is slung to a twig of a tree by a few slender grass threads. The bird loves to live in colonies, and you may find as many as twenty or more of these ingenious and beautiful nests hanging to the branches of a tree. A few years ago a Forest Officer, endowed with keen powers of observation, discovered the origin of many up to then unexplained fires in parts of the Assam forests. A fire backed by a high wind would reach a broad boundary line which had been carefully cleared during the cold weather, and would be there checked and beaten out. Yet it was often found that fires started, as if by themselves, in parts of the forest beyond, without having crossed the trace. The following simple explanation was discovered. Colonies of this little weaver bird built their nests in small trees situated on the outer edge of the forest near the boundary lines or fire traces. These nests were tenantless in the hot weather season. As a fire came up with a strong wind behind it, the dried grass nests caught fire, the few strands by which they were attached to the trees were burned through at once, and the burning nests, acting as so many fireballs, were swept by the wind many hundred yards away into the forest on the far side of the carefully swept fire-line, thus starting fresh fires. It is now the duty of the men who clear the fire-lines in the cold weather season to search for all adjacent weaver bird nests and cut them down and burn them.

One more illustration of a Forest Officer's work and I have done. He will find almost in whatever country and clime he may serve in, that he will, sooner or later, be faced with planting problems, with knotty points connected with the thinnings of his woods, and with still knottier ones in connection with the extraction of the timber. Now the forester must be able to grapple with all these, and he will only be able to do so efficiently in proportion as he has been trained to his work, and in proportion *bien entendu* as he has kept himself *au fait* with forest literature and the accepted opinions of the men of the day on forest subjects. Nowhere, perhaps, in the world have men had to face more difficult

problems connected with planting than in India. Here in Scotland I may be told there are worse ones. Well, picture to yourself a southern aspect in India exposed to the full sun of a long hot weather in a dry arid country; the soil composed of part rock, part sand, the surface sparsely covered here and there with a spiny growth of shrubs, which no known animal on the surface of the earth can grapple with save the goat and camel; the area is exposed to constant denudation from landslips which are gradually covering up the fertile, arable land below. The hillsides are still grazed over by numbers of goats and sheep who, in their search for such sustenance as the area provides, trample down what little growth exists and aid in the denudation work going on. The orders of the Forest Officer are to replant the area, an area known to have been covered with a fine forest a century or two ago. It is heart-breaking work and requires a high skill, combined with higher training, to produce results in such places. And yet they have been produced, and that in spite of the assertions on all sides that no trees would ever grow there. I do not know that the forester is more optimistic than men in other avocations, but it requires a good deal of evidence, combined with practical demonstration, to convince the experienced, tried, practical forester that trees of some sort will not grow in any given locality below that of the permanent snowline. The particular species tried time and again may not succeed, but others doubtless will.

These practical illustrations from a Forest Officer's life have been given with a purpose. They serve to show, I think, the nature of the training the forester requires if he is to be able to efficiently carry on his multifarious duties and at the same time satisfy himself that the woods under his charge are, each one of them, getting exactly the treatment they require from year to year. They also emphasise the fact that the forester is learning all his life, that there is something for him to observe, some little secret of nature for him to pick up every time he goes out into the woods. It follows, therefore, that it is never too late to improve one's education as a forester. That though one may have begun by only following a part of a course in Forestry, only have taken the

more simple and elementary branches, that it is always possible to go back from the woods to the class-room. The absence in the woods has not brought forgetfulness of what we learnt at our former course, rather has it brought an increased power to assimilate the higher branches of the science of Forestry. So many things explained in the class-room, we shall remember to have noted out in the woods as requiring explanation. Therefore, I would say to the student commencing his Forestry course, take every advantage of what you are told in the lecture room, observe all you can in the woods when taken there for practical work, for in the future you will be able to turn this practical knowledge to use; even the very existence of the woods in your charge may some day depend on your acting promptly on the lines you were taught as a student.

To him who has followed the elements of the science and then gone out into the woods to practise it, I would say, forsake the woods for a brief spell, come back to the class-room, and the fuller outlook and wider sphere which will open out to you on your return will well repay you for your perhaps uncongenial labour at the desk. You will never regret the step.

And now I must briefly glance at our preparation here in the University to receive those of you who come back to us from the woods, to those who commence within these walls that apprenticeship to the life of a forester which I for one believe they will never regret.

As many of you know, the University grants a degree of B.Sc. in Forestry, the only University in Scotland or England to do so. That is our patent to you who come to us, the hall-mark which will warrant each man we send out as qualified to undertake the work of a forester. But we hope to equally hall-mark those who return to us for the higher course of training, and yet who will be unable to put in the three years of residence at the University which the degree requires. Those others who return I trust will be equally marked by us on leaving when they have satisfied us that they are fully qualified. This is what I hope we propose to do. Let us now glance at our means of doing it.

To teach the science of Forestry efficiently requires, as we have seen, three essentials :—

1. A sufficiently strong Staff.
2. Good Museums.
3. A Forest Garden and Demonstration Forest.

1. *The Staff.*—We have seen the strength of the staff which the European Forestry colleges consider necessary. The staff for Forestry tuition at Edinburgh can compare in all save one respect with that of any other University or college in the world. The point, however, at which it is at its weakest is one of the places where it should be strongest. I speak of the strength of the staff responsible for the Forestry portion of the education, the most important part to the students.

So far as our first course in Forestry is concerned we are all right. We could even manage the theoretical portion of the higher course which, it is proposed, shall be given in the winter session, although it would involve the burden of delivering two lectures a day in addition to the field work of the first course men. The staff breaks down entirely, however, when we come to consider the supervision of the very important practical work of the higher course men, which must go hand in hand with their lectures. It is absolutely essential that this work should be personally supervised by the lecturer, an impossibility when he will have the first course men on his hand at the same time. If I am asked why one of the courses should not be given in the summer session, the reply is that the summer session is far too short to deliver either of the courses adequately. I propose that the summer session shall be devoted to practical work in the woods by both junior and senior students, but they will not be working together nor visiting the same woods, since what the juniors are being shown the seniors will have already seen. Further remarks under this head are unnecessary, I think, to show what is required if we are to educate men qualified to hold our Degree in Forestry.

2. *The Forestry Museums.*—Thanks to the initiative and energy of my predecessor, Colonel Fred Bailey, this University is in possession of a Forestry museum which can compare favourably

with any that I have seen in the British Isles. I do not suppose that Colonel Bailey for one moment considered that he had all the specimens he wanted to illustrate his lectures, but for a first course in Forestry—and it was for this that Colonel Bailey made his museum—it is an excellent one.

We have now to give the higher course in Forestry, and are faced with the question of making large additions to the museum. There will be no difficulty, I think, in this, so far as the specimens wanted are concerned. The difficulty occurs when we consider the present space available. It will be quite inadequate. I think I may claim that I have made a close study of museums of the kind we are considering, and one of the first necessities of a museum to my mind is to so arrange the exhibits that it may be possible for the student to examine those of a class together, and not find all sorts of different classes of objects mixed up in a promiscuous manner. With the former system the museum can assist greatly in education. In the latter it only remains a weariness to the flesh, and sends one away tired and muddled with the variety of different objects we have been endeavouring to fix our attention upon at one and the same time. We have seen the space devoted to Forestry museums on the Continent. I shall hope to approach the University in the near future with a scheme for the provision of adequate space for our Forestry exhibits.

3. *The Forest Garden and Demonstration Woods.*—So far as woods of a high educational value go, Edinburgh is undoubtedly better situated than any other Forestry centre, out of Scotland, in the British Isles. There are woods in Scotland, many of them known by repute, in which the student on his practical courses can learn a great deal. In fact, supplemented with some object-lessons on the Continent, we may say that this part of the student's practical work can be fully arranged for. We have not had, however, in the past, either a forest garden or a series of forest demonstration woods similar to those I have described at Tharandt. We have not had areas to which the students can be taken constantly, during the theoretical portion of the training, so that this

essential portion of the practical course can go hand in hand with the class work.

Now, students working for a Forestry Degree cannot be trained without the provision of such an area. Forestry, in the opinion of all practical foresters, cannot be taught at all without such an area. My predecessor made great efforts to obtain such an area. Prof. Bayley Balfour placed the resources of the Botanical Gardens with its very useful arboretum at his disposal. It will ever form, I trust, a most useful aid to our training. But Prof. Bayley Balfour would not care to see twenty students trenching one of the banks of his beautiful gardens or preparing nursery beds on a lawn. And yet, a Forestry student must go through this practical work, or how is he to know whether the work is done well or ill when he has charge of woods in the future? Similarly we want to fell trees. Good-natured aud public-spirited as our neighbouring proprietors of woods are, we can hardly expect to be constantly received with open arms when our desire is to fell and measure up sample trees or show the students how to thin an area. For our higher training in some of these directions I shall trust to avail myself of the many and generous offers I have received to bring my students to make thinnings in woods which require such work done in them sylviculturally; but for the practical work, which must go hand in hand with the lectures, it is essential that we should have an area in the vicinity of the University under our own direct management where we can make a good nursery in which generations of students will, in their day, prepare beds, sow, plant and transplant; an area where the students can be taught how to trench and drain; an area where they themselves will plant out young trees to form woods which they will be able to return to and inspect in years to come; and finally, an area where we can experiment with various species and mixtures and undertake different methods of planting with a view to doing our share towards solving some of the many pressing problems which await solution in Scotland.

Our forest garden and demonstration woods would fulfil several purposes, for we should welcome one and all who care to visit

them, either to work in them as students or to make use of any of our methods which have proved successful.

Such an area as I have described exists in the vicinity of Edinburgh, and I cannot press upon the University too strongly the vital importance which exists that we should endeavour to acquire it at the very earliest possible moment. So far as the Forestry Department is concerned, it is one of the most important questions resting with the University for early consideration, for upon it depends, must depend in the eyes of the practical forester, the whole of the question of the qualifications of this University to grant a Degree in Forestry which will be recognised as an asset of value in the Forestry world.

ORIGINAL ARTICLES.

TEAK IN BURMA.

In sizing up the practical results of the first Burma Forest Conference with special reference to the chief cause for its convocation—the elaboration of a more truly scientific method of working the Burma teak forests than the present temporary makeshift—the economic forester is at once struck by the failure of the proposed system to ensure the maintenance of the increment, by the lack of recognition accorded to the interdependence between yield and induced increment. A certain yield is to be prescribed, the replacement of the increment of which is to be assured by the concentration of improvement fellings upon a small area, so small as to be a fraction (about $\frac{1}{8}$th) of the area exploited; and the improvement fellings are to be so thorough and continued that no doubt can exist as to the ultimate attainment of an exploitable size by the suppressed trees freed in these operations. Surely, this is the cart before the horse, and the chickens before their hatching. A yield cannot be prescribed until an increment is assured. And what assurance have we for any increment beyond that of the dominant growing stock? Compromises and half measures are beloved of the British, but economic forestry

does not admit their employment. It is such a pity to take two bites to a cherry. Let us recapitulate some of the considerations guiding the Conference :—(*a*) There is much overmature teak in our forests which it is financially undesirable to retain, and which the market badly wants ; (*b*) if we take out this mature teak we ought to replace its increment ; (*c*) generally speaking, the less delay in the extraction of this old timber the better, provided always that it is replaced by vigorous young stock and that the market is not flooded with irregular supplies ; (*d*) the old method of carrying out improvement fellings is unsatisfactory in that it dissipates the energies of the limited staff ; (*e*) it is no use proposing for improvement fellings an area larger than the staff can deal with, preferably let us concentrate.

The conclusion of the Conference is that the available skilled labour should be concentrated on to improvement fellings over a small area with the object of freeing so many seedlings as to obtain about five times as large a stock of teak on that area as there was before. With this justification, extraction is to be allowed to proceed over five times as large an area as that worked over with concentrated improvement fellings.

Leaving out the question of undue optimism in expecting to find so many seedlings on the ground and apart from the doubt as to the number of these which may be expected to attain maturity, why is the area so limited ? The general opinion is that improvement fellings can be carried out properly only by a skilled and trained Forest Officer ; one working-plan lays down that they should be carried out under the supervision of a gazetted officer. I have expressed myself in these columns before to the effect that Burmese labour can be trained to carry out improvement fellings with no great difficulty, and the reiteration of this opinion may perhaps induce some Divisional Officers to try.

To my mind a consideration of the facts before us carries one simple solution—the utilisation and development of local labour. I would train four to ten carefully chosen intelligent foremen and give them two compartments each to work over with improvement fellings : it takes two months to work over a square mile really well :

I would pay them Rs. 50 per month each while employed, and in addition give out the work to them by contract per acre. A few years' experience and inspection would, I have little doubt, prove the possibility of carrying out concentrated improvement fellings over as large an area as might be desired and without dislocating the permanent staff at all. Of course there would be difficulties but with a local staff of ten such men in each division, our labour troubles *would soon diminish and the goodwill of the people* become a much more real thing than at present. The employment of local labour is an axiom in Europe; after some years' experience, if you make it worth a man's while, he will train himself. Our permanent staff should be considered not collectors of labour and coolie-foremen, but supervisors.

When we can carry out improvement fellings not only *intensively but extensively and proportionately to exploitation, then* we shall be justified in taking out the amount of yield prescribed in most Burma working-plans of the last twenty years. Till this is the case, we ought to limit our reduction of the increment producing growing stock by the amount of additional increment we can induce; as, under present conditions, this can be shown to be financially unsound, we must increase our area *of concentrated improvement fellings and we must decrease not* one whit their intensity; to be able to do this we must employ local trained labour, and to obtain this labour we must pay it well. To carry these ideas into effect practically, we must first determine the "possibility" by calculation based on rate of growth much on the usual lines; we must then determine the minimum, that is, the amount of growing stock we are justified in removing, knowing that even now we can replace its power of *yielding increment by* freeing a proportionate number of suppressed seedlings. This minimum should then be fixed as the outset yield, and as soon as adequate measures have been taken by more efficient organisation, by improved labour-supply, by decentralisation, or by any other means actually to increase the induced increment, then we may increase our outset yield, a sliding-scale being thus created between the maximum and minimum limits based on the real results

of measures taken to establish the normal increment. With working-plans once sanctioned on this true economic basis, the Government would soon wake up to the necessity of giving us a staff adequate in numbers and skill to ensure the replacement of our growing stock, thereby enabling us to increase our yield; and the duty of the Divisional Forest Officer in this respect would then take its proper place as the chief of his responsibilities.

I am well aware that many will say the time is not yet, that the idea may have some sense in it, but in practice the intelligent reliable foremen are not to be found, and that evidently what I need is a bit of practical work: my answer to this is that if these proposals are unsound, then it is in the method of their application that the fault is to be found. The one certain conclusion is that the Forest Department in Burma must make some sort of organised start in the direction of utilising and developing local labour.

I should like to see the Chief Conservator order the personal training by the Divisional Officer of ten improvement fellings supervisors in each Division, and a subsequent inspection by the Chief Conservator in certain selected divisions of the men and their work. It is hard to suggest anything upon which the Divisional Officer would be better employed. Only by some determined action of this sort carried through with a disregard for all side-issues and with a single eye to the permanent realisation of the object to be attained, the establishment of the normal increment, can we expect that thorough revolution in our methods of recruiting labour and determining yields outlined above.

"•OP."

THE BAMBOO FORESTS OF THE GANGES DIVISION.

I have to thank Mr. Lovegrove for his kindly criticisms on my article on the Bamboo Forests of the Ganges Division published in the August number of the *Indian Forester*, and would ask to be allowed to say a few words in reply.

Mr. Lovegrove begins by referring to the extension of the felling rotation from two to three years, and is under the impression that I am not satisfied with the condition of the clumps,

consequent on the introduction of the three-year period, and quotes me as saying " it seems probable that the production of culms has diminished." Both my expression of dissatisfaction with the present state of the clumps in the more accessible forests, and the remark regarding the probable diminution of the culms, were made in comparing the present condition of the Bamboo Forests with what they are said to have been in former times, and this part of my subject was begun on page 206 of the *Indian Forester* with the words " Complaints have from time to time been made... ....." The sentence quoted by Mr. Lovegrove occurs on page 207, and refers solely to the production of culms at the present time as compared with the production in former times, when the working was not so intense as it is now. That part of my subject which compares the results of the two-year and three-year rotations begins on page 208 with the words " As regards the respective merits of the two-year and three-year rotation........."

This latter sentence should have begun a new paragraph to show a change of subject, and it is probably this error which has misled Mr. Lovegrove.

The conclusion I arrive at regarding the three-year rotation is contained on page 209 of the *Indian Forester* in the words. " It appears reasonable to assume that the three-year rotation will give favourable results both as regards outturn and revenue in the more accessible and heavily worked forests." So convinced am I of the advantage of the three-year rotation in the latter class of forests, that on page 219 I have advocated the extension of this rotation to some of the blocks which are at present being worked in alternate years.

Mr. Lovegrove and I seem to be in perfect accord as to the cause of " congested " clumps, *namely*, that a ring of dead rhizomes is formed round the outer periphery of the clumps which prevents the outward extension of the rhizomes, and forces the reproductive power of the root-system *inwards*. Mr. Lovegrove also agrees that this ring of dead rhizomes is produced by the removal of culms above, and says " I also tried to explain that the rhizomes died when culms above had been removed." I venture to think

that this last sentence is too vague, as the length of time which it takes for death to reach the rhizomes does not depend merely on the cutting of the culm above it, but also on the manner in which that culm has been cut, and herein lies the whole crux of the matter. In his article in the *Indian Forester* of September 1900, Mr. Lovegrove showed that the stump of the bamboo died down at the rate of one inter-node per annum, it follows therefore that the greater the number of inter-nodes left on the stump the longer will it take for death to reach the rhizome. This is a sylvicultural fact which is admitted by Mr. Lovegrove. The converse is equally true, *viz.*, the fewer the inter-nodes left on the stump the more quickly does death reach the rhizome; and carrying the argument still further, if the culm is cut at, or below ground-level (leaving no inter-node) the rhizome will die the same year and its further outward expansion ceases. And if this system of low cutting is continued right round the clump the rhizomes on the outer periphery will be killed rapidly and thus produce the ring of dead rhizomes to which Mr. Lovegrove refers. The photographs of uprooted congested clumps, which accompany my article, show clearly the mischief which has been wrought by very low cutting. During the last five years I have carefully examined thousands of bamboo clumps, and I have no hesitation in saying that very low cutting is distinctly injurious to the root-system and tends to destroy the fertility of the rhizome.

I am perfectly aware that many Forest Officers look with horror on stumps two and a half or even two feet high. But I think it will be observed that these are officers whose experience extends only (or chiefly) to forests of congested clumps of bamboos. In such cases the leaving of high stumps is undoubtedly harmful, and when I advocated the abolition of the low-cutting rule, I especially stipulated that this should not apply to forests which contain a large percentage of congested clumps.

Under normal conditions the bamboo clump will grow *outwards*, as pointed out by Mr. Lovegrove, and as the felling in this Division is very intense the clump remains very open, and consequently I do not see the harm of leaving stumps 2 feet or 2½ feet

but gives no reason for the latter assertion.

My chief objection to the present classification is that there is no *differentiation* between different kinds of bamboos, provided only that they are of the same length ; so that the royalty on a thick tent pole 15 feet long is the same as on a thin bamboo of the same length which has only one-sixth the economic value of the former.

I think it will be admitted that this principle of appraising our products can hardly be correct.

In suggesting the adoption of the local nomenclature, I have given the lengths as well as the local names of the various classes of bamboo, so that my proposal is in reality an amplification of the present classification, and its adaption to local trades customs, and is, I venture to think, a distinct improvement on the old system.

(2) I am afraid that the plan proposed by Mr. Lovegrove would be very difficult to enforce practically, not only because an average such as suggested would be unreliable for any particular year, but the contractors would bitterly resent the restriction regarding their *maximum* outturn.

The sylvicultural requirement is that *each clump* should have a certain number of old shoots left in them, besides the culms of the year, but I do not see how this result would be obtained under Mr. Lovegrove's proposal, even if such a rule could be enforced. Because restricting contractors to a certain maximum outturn does not ensure that old culms will be left in *each clump* from which bamboos are cut, and hence the sylvicultural requirement at which the introduction of this rule aims would not be attained.

LANSDOWNE, U. P. : B. A. REBSCH.
19th September 1910.

FIRE CONSERVANCY IN INDIAN FORESTS.

In the October number of the *Indian Forester*, Mr. Latham raised two objections to my account of the effect of burning the leaves. The first is that the carbon of the dead leaves, converted by fire into carbonic acid gas and driven into the atmosphere, is

totally lost owing to strong winds. His objection, however, has no force unless it can be shown that there is some definite advantage in preventing the burning of the leaves. The action of fire converts the carbon into the only form in which it can be reassimilated, and distributes it to the only place, the atmosphere, where it can be of any use to future crops. It is evident therefore that no harm is done. On the other hand, in protected areas the carbon is useless so long as it is locked up and retained in the dead leaves. Ultimately, however, as the result of decomposition, it unites with oxygen and is also liberated as carbonic acid gas into the atmosphere, where it is similarly liable to be carried away by strong winds. There is therefore in this respect no advantage gained. Mr. Latham's objection, in fact, merely amounts to this, that, as the atmosphere is never still, plants cannot depend entirely on the CO^2 generated in the immediate locality for their supplies—and the same holds good in respect of hydrogen and oxygen—but seeing that the atmosphere is calculated to contain 3,400,000,000,000 tons of carbonic acid gas, I think we can rest assured that whether an area is fire-protected or not, plants have no difficulty in obtaining ample supplies of carbon.

The chemical effect of decomposition is, I think, almost identical with that of combustion, but not so rapidly completed, and, in any case, if the chemical action of fire on the carbon, hydrogen, and oxygen of the dead leaves does not prejudice the growth of future crops, the greater part of the volume, about 98 per cent, is satisfactorily accounted for.

Mr. Latham's second objection is more serious. He maintains that the remaining two per cent, comprising all substances derived from the soil and required in the soil again for future crops, is totally lost by the action of gales and torrents of wind. If he put his argument in full, it would, I think, run as follows. Ashes being exceedingly light must be blown away many miles by wind, and on the break of the rains the balance must be floated away into streams. Therefore the calcium potassium, etc., it draws out of the soil must be gradually exhausted. Therefore future crops must deteriorate.

How is it that we invariably theorise from doubtful premises up to facts, and insist that our conclusions must be correct when an examination of the forest would show exactly what the facts are? I do not think we quite realise how greatly we allow our imaginations to run riot, and as this seems to be cause of innumerable mistakes and misconceptions I will go into the matter in some detail. I submit that it is generally practicable, and is the only sound method to ascertain what the facts are first, and to be guided by them entirely. Having done so, it is of great assistance in understanding the facts, although it is not essential, to discover some reasonable explanation as to how the facts have been arrived at. I could give many examples to illustrate my meaning, but I think it will be sufficient if I take the three main reasons given for attempting fire-protection in Burma. The first is that it was supposed that fire-protection would increase the stock of teak. Knowing that fire occasionally destroys some seeds, seedlings saplings and trees it was assumed that fire-protection would increase the stock by the amount which would otherwise have been destroyed by fire. When the facts are examined however it was found that fire-protection had caused natural reproduction to cease, and that seedlings and saplings had been badly suppressed. Explanations then at once suggested themselves, such as that teak had lost the great advantage it possessed in the struggle for existence in being better fitted to resist fire than other species.

As regards the second reason, knowing that wood is inflammable it seemed the obvious conclusion that annual fires must cause colossal danger. On the other hand, there is no altering the fact that overmature and even dead standing teak trees resist fire most successfully, and that few trees bear more than slight scars which do not appreciably affect the value of the timber, and a simple explanation at once suggests itself, that the fires are mild and teak well fitted to resist them. These facts have been established, although for many years any discussion was deprecated officially, and are not now, I think, seriously disputed, but even now fire-protection continues our principal work in Burma, and I can only account for this by the existence of a feeling that it is the duty

of facts to fit the theories, and that if the facts do not bear out obvious conclusions, the evidence should be mistrusted rather than the logic and method of reasoning.

The third reason is the one under discussion. Mr. Latham's contention at first sight seems perfectly reasonable, but I cannot accept his conclusions because, after seeing forests which I am certain have been burnt over annually, not for one or two years, but for many centuries, the growth taken as a whole seems to me distinctly good. Growth varies of course according to the soil, and is frequently very poor on ridges and steep hillsides, but if there were any deterioration due to the exhaustion of any substance necessary to plant growth, such as is noticed when an exacting field crop is grown for several years in succession, the deterioration of growth would be *general* throughout the whole forest.

Ashes consist mostly of extremely fine particles, and although flakes of burnt leaf are found these are rapidly pulverised, when well shaken and stirred as is done naturally by strong winds. These particles, when scattered in the wind, are hardly visible, and as it is almost impossible to see what does become of them, Mr. Latham therefore cannot be quite certain of his premises. His conclusions however are based entirely on the extreme lightness of ashes. He has been misled I think by the lightness of a flake of burnt leaf, but even gold, when made into finely pressed leaf, is light enough, and for the same reason, because a large surface is exposed. True ashes containing the calcium, potassium, etc., derived from the soil are really distinctly heavy, a fact which can be easily proved by throwing a few ashes into water when it will be found that they sink immediately, and hardly even discolour the water. If they are kept for a few days they seem to become slightly damp, due probably to the fact that they attract hygroscopic water, and this would also tend to prevent them being carried away by the wind. Even the solid matter in smoke, consisting, I believe, of small flakes of carbon, which must be comparatively extremely light seeing that they are carried up by the hot air when ashes are left, fall to ground very soon, as is proved by the fact that the grime is greatest in the centre of a smoky town and

decreases rapidly with the distance, and therefore it seems to me highly improbable that ashes should be carried away for miles as suggested by Mr. Latham, even by the strong winds we get in India.

As regards the effect of torrents of rain, the experiment referred to proves that ashes do not float. Apart from this the rain causes the particles to cohere in the manner known to us in the case of the fine dust on an unmetalled road as "laying" the dust. Moreover it is only the first few drops of rain which materially affect the ashes, and as on the break of the rains the soil is exceedingly parched, the whole of these are absorbed and carry the ashes with them into the soil. It does not seem to me probable therefore that any considerable proportion is washed away.

When leaves are not burnt the result is, I think, eventually to give off into the atmosphere all substances capable of being evaporated, and to restore the non-volatile substances back to the soil from whence they came, in extremely minute particles identical with those resulting from combustion. I fail to see how in the tropics the chemical action of decomposition can increase the quantity of these substances, nor that of combustion decrease them. These substances are however mostly soluble in water, being indeed usually taken up by plants in the water absorbed by the roots, and as the surplus water percolates more slowly through the spongy layer of leaves in a protected area, more time is given for these substances to be dissolved. As however a large proportion of the water received is drained away into streams, it is not improbable that even in a protected area a considerable amount of nutritive matter is carried away. But in either case, if there is any loss, however caused, I am forced to the conclusion, by the rate of growth which on the whole seems to me reasonably good, that the loss must be made good by the natural renewal of the supply.

It is not improbable that several advantages are claimed for fire-protection on account of the mechanical or physical, as distinct from the chemical, effects of the preservation of the dead leaves, and I take this opportunity of discussing a few of the principal points. The importance of preserving the dead leaves

in temperate climates is clearly established. For one reason the resulting humus is beneficial, especially in stiff soil, because it renders the soil more porous, but in these tropical forests decomposition is so rapid that true humus is not formed, and even in an area protected for many years no intermediate layer of gradually decaying matter between the recently fallen leaves and the soil is ever found.

It may also be claimed for this layer of dead leaves that it retains the moisture and retards evaporation. This may be important in temperate climates where growth takes place in the hot and dry season, but not, I think, in Burma where the growing season is the rains, and where even in unprotected areas the soil is thoroughly saturated.

One would also expect the layer of leaves to prevent the water after heavy rain being drained off so rapidly, and therefore to reduce the floods during the rains, and to increase the flow in the hot weather. On theoretical grounds I should have expected the gain to be very considerable, but actually I have not found that floods materially decrease when an area is protected, nor that the flow in the hot weather is greatly increased. Possibly the reason why the difference is not greater is that the soil is super-saturated.

The most difficult question of all, I think, is, whether or not fire-protection materially reduces erosion. There is of course no disputing the fact that on ridges and steep hillsides the soil is usually extremely shallow, but considering the steepness of the slopes and the heaviness of the rain could it be otherwise, even with fire-protection, and is the soil actually more shallow than in areas where fire is unknown? In a protected area the leaves on a steep slope, being frequently stirred by the wind, often gravitate to lower levels, while in an unprotected area some débris escapes being burnt or falls after the fire has passed through, and on the break of the rains a multitude of small weeds and herbs spring up and prevent the rush of the water, so that the conditions are equalised, I think, more closely than one would expect. The amount of matter held in suspension in the water in the streams should afford some indication, but I have not noticed that the streams in a protected

area are more clear and sparkling than those in unprotected areas.

One may sometimes find the lateral root of a small sapling exposed and it is evident that if erosion proceeded at the same rate the whole tree would be uprooted before obtaining maturity, but except near streams where the channel has altered, I have seldom seen a tree entirely undermined. I have moreover seen exactly the same indications of erosion in protected areas, but in the same way that a stream may scour out a new channel without deepening the stream as a whole, so also, I am inclined to think, some obstruction may cause rapid erosion in one place, yet that when the obstruction disappears, the depression may be filled up. At most fire-protection can only retard erosion and however slowly it proceeded, if unchecked, all the fine soil would eventually be removed, leaving the underlying rock exposed. It is evident therefore that some sort of limit is reached beyond which erosion is balanced by the formation of new soil, and I think it is merely a question of whether fire-protection can in any way alter the equilibrium. Personally I am inclined to think that fire-protection has had some slight effect, due not so much to the layer of leaves as to the greater volume of vegetation, but I do not think that fire-protection, however long continued, will ever result in deep soils on steep hillsides or make any material difference.

On the other hand, the exposure of the soil owing to the burning of the leaves certainly has some advantages. For instance the contraction and expansion of the soil serves the same useful purpose as frost in colder climates, and the view has recently been established that the heating of the soil increases the fertility.

As our forests are uneven aged it is almost impossible to obtain any reliable statistics of the comparative rates of growth, but in the two or three cases where some figures have been obtained, the result has indicated invariably that the rate of growth is slightly better in unprotected areas. The results may have been brought about by other factors and are untrustworthy, but the fact remains that what little direct evidence there is, is opposed to the supposition that the burning of the leaves affects growth prejudicially.

The whole question has, I think, at present merely an academic interest, but as it constitutes the only reason left for continuing fire-protection in Burma, it has attained a totally fictitious importance. Teak is not an "exacting" species, and so long as we cannot control the struggle for existence, fertility is almost a disadvantage, as it promotes a luxuriant growth of vegetation against which the natural teak, being a light demander, cannot compete.

Although, however, I do not consider the question important in itself, yet I think it illustrates, in various ways, how thoughtlessly we jump to conclusions and allow ourselves to be swayed by the constant and emphatic reiteration of sweeping statements, based possibly on research in cold climates, but not found on an examination of the conditions and facts in India.

AKYAB: H. C. WALKER.
November 1910.

EXTRACTS FROM OFFICIAL PAPERS.

PROCEDURE TO BE OBSERVED IN DEALING WITH FOREST WORKING-PLANS.

Government of India Circular No. 29-*F*-160-14, *dated* 23*rd September* 1910, *to all Governments and Administrations.*

I am directed to say that, after considering the replies received to this Department's Circular No. 16-F.-160-1, dated the 31st May 1910, the Government of India have decided to lay down the following procedure to be observed in dealing with forest working-plans, and the checking and submission of 'control forms.' The new procedure should be brought into force from the 1st January 1911 :—

(*i*) In provinces where there is a Chief Conservator of Forests, the final scrutiny and check of forest working-plans, before submission to the Local Government for sanction, will be left to the Chief Conservator and the Inspector-General of Forests will have no concern with the preparation of such plans unless the Local Government desires his opinion.

(*ii*) In provinces where there is no Chief Conservator of Forests, the procedure as laid down in sections 85 and 90 of the Forest Code will remain unchanged and preliminary working-plan reports and completed working-plans will be submitted to the Inspector-General of Forests *direct*. Circular No. 17-F., dated 13th July 1906, is hereby cancelled.

(*iii*) Copies of sanctioned working-plans will in all cases be forwarded to the Inspector-General of Forests for information and record.

(*iv*) The Inspector-General of Forests will be at liberty to bring defects in working-plans of all provinces to the notice of the Local Government concerned.

(*v*) The rules regarding the submission and checking of 'control forms,' laid down in this Department's Circular No. 37-F-344-14, dated the 13th December 1906, will remain unchanged with the exception that signed copies of the forms will be forwarded on the prescribed date to the President, Imperial Forest Research Institute, Dehra Dun, instead of as at present, to the Inspector-General of Forests (care of the Superintendent of Working Plans), by the officer by whom the forms have been checked.

2. Under the arrangement prescribed in paragraph 1 (*ii*) above, the examination of working-plans from provinces in which there is no Chief Conservator of Forests will in future take place in the office of the Inspector-General of Forests at head-quarters. The Imperial Sylviculturist will therefore no longer be Superintendent of Working-Plans and he will cease to use the latter designation.

3. I am to add that the necessary corrections will be made in the Forest Department Code now under revision.

RULES FOR THE ENTRY INTO THE FOREST DEPARTMENT AS RANGERS OF NATIVE NON-COMMISSIONED OFFICERS OF HIS MAJESTY'S INDIAN ARMY.

Government of India Resolution No. 32-*F.*-262-2, *dated 22nd October* 1910.

As certain alterations are necessary in order to bring up to date the rules promulgated with this Department's Circular Resolution No. 28-F., dated the 30th November 1893, for the entry into the Forest Department as Rangers of Native Non-Commissioned Officers of His Majesty's Indian Army, the following rules are issued in supersession of those contained in the above-mentioned Resolution :—

I. Any such officer, who is recommended for the purpose by his Commanding Officer may apply to a Conservator of Forests in the province in which he desires to be employed for permission

to follow the course of instruction in the Ranger class at the Imperial Forest College at Dehra Dun with a view to secure, after successfully passing through the College and obtaining a certificate an appointment as Forest Ranger in the Subordinate Forest Service.

II. The Conservator to whom application is made must be satisfied—

(*a*) that the candidate will not be more than 30 years of age when he enters the College;

(*b*) that he has been sufficiently well educated, especially in Mathematics and English, to enable him to follow the College course with advantage and to obtain a Ranger's certificate;

(*c*) that he is of good constitution and active habits, and possesses fair ability and powers of observation, as well as such physical qualifications as are required for a good Forest Officer.

III. If the conditions in the preceding rule are satisfied and the candidate is accepted by a Local Government for an appointment in the Subordinate Forest Service, he may be admitted to the College, and be allowed to receive the stipend admissible to Government probationary students under rule 12 (*vii*) of the Forest College rules. While at the College, with the exception that he need not attend drills, he will in all respects be subject to the rules for the time being in force, a copy of which can be obtained from the Principal of that institution.

IV. On obtaining a certificate at the conclusion of the Ranger's course the candidate will be eligible to be appointed as Ranger. On being so appointed he will be subject, as regards future promotion, to the regulations of the Forest Service for the time being. As regards other conditions of service, the candidate either shall, on obtaining his appointment to the Forest Department take his discharge from the Army, and then 12 months of his period of instruction at the Forest College will count as service under Article 356, rule (3) of the Civil Service Regulations, 5th edition, or he may serve in the Forest Department and be transferred

to the Native Unattached List under the conditions in Army Regulations, India, Volume II, paragraph 388, and in that case he will qualify for the special rates of pension admissible under military regulations [*see* Army Regulations, India, Volume I, paragraph 1044 (*a*) (*v*)].

V. During the College course the candidate will be seconded in his corps, which he shall rejoin if he fails in obtaining a certificate.

2. These rules do not apply to the Presidencies of Madras and Bombay; but the Governor-General in Council recommends them to the consideration of the Governments of those Presidencies.